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PAN-AMERICAN ENGINEERING EDUCATION

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JANUARY, 1961 Vol. 51, No. 4

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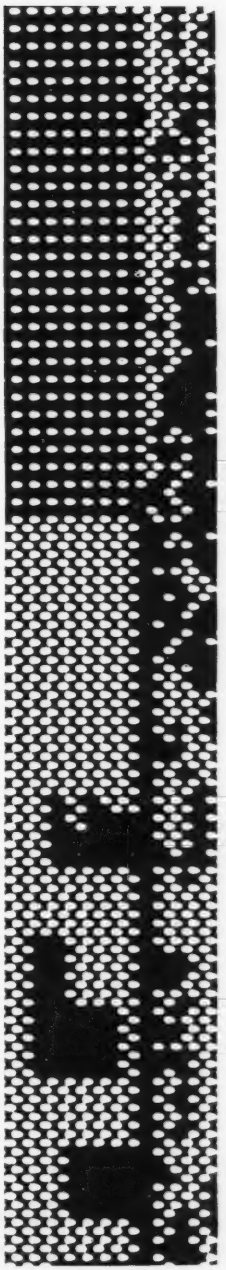
A HISTORIC TELEPHONE EXPERIMENT BEGINS IN AN ILLINOIS TOWN

Today, the science of communications reaches dramatically into space, bouncing messages off satellites. But an equally exciting frontier lies closer to home. Bell Laboratories engineers have linked a revolutionary new central office to the telephone system in Morris, Illinois.

This is a special electronic central office which does not depend on mechanical relays or electromagnets. A photographic plate is its permanent memory. Its "scratch pad," or temporary memory, is a barrier grid storage tube. Gas-filled tubes make all connections. Transistor circuits provide the logic.

The new central office foreshadows new kinds of services that will be explored first in Morris with a small group of customers. Some day it may be feasible for you to dial people you frequently call merely by dialing two digits . . . have your calls transferred to a friend's house where you are spending the evening . . . to have other numbers called in sequence when a particular phone is busy.

The idea behind the new central office was understood 20 years ago, but Bell Laboratories engineers had to create new technology and devices to bring it into being—another example of how Bell Telephone Laboratories works to improve your Bell communications services.



Part of a memory plate of the new electronic central office is shown at right (enlarged 8 times). Spots are coded instructions which guide the system in handling calls and keeping itself in top operating form. Over two million spots are required. Logic and memory are physically separated in the machine, so new functions can be easily added. The experiment is being conducted in co-operation with the Illinois Bell Telephone Company and the Western Electric Company.

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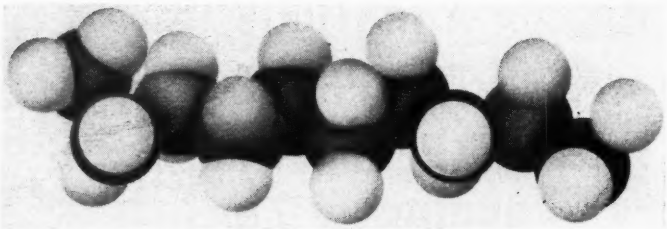

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Comparison of (a) gyromagn measured in the new Ketter Magnetics Laboratory with (b) corresponding ferromagn resonance measurements. Th would equal 2 if magnetizati due only to electron spin, or due only to orbital electron m

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MECHANICAL ENGINEER WITH 10 years experience teaching power plants, heating, air conditioning in university and 20 years in consulting engineering seeks change for September 1961. Write to 51-3, *Journal of Engineering Education*, University of Illinois, Urbana, Ill.

Do You Know

► That the ASEE headquarters staff wishes each of you a Happy New Year? This is the only means of direct communication with all of you, except for the dues notices, and so the opportunity is taken to say to each, "May the good Lord look kindly on you and enable you to enjoy your blessings to the fullest; may happiness, good health, and the inner satisfaction of a job well done be with you throughout the year."

► That the Projects Management Group has had its first meeting? The responsibilities of PMG were reviewed in the November "Do You Know." You will recall that its basic purpose is to review and initiate proposals involving funds from non-ASEE sources and to follow them along to ultimate action programs based on the results of the studies. Neither the Executive Board nor the General Council has the time to do all these things. Some five proposals already are in the hands of the Committee, one of which is a plan for financing the work of PMG and employing adequate secretarial help. When the decision was made last June to establish PMG it seemed fairly certain that the Ford Foundation would provide support for it and other ASEE projects. Now, after five months, it has been learned that the Ford Foundation will *not* support ASEE projects. Our eggs were in the wrong basket, and other support, particularly from NSF, is now being sought.

► That the work of CDEF is being continued as a three-pronged program. ECAC has faculty *recruitment* as its chore, a new committee under Ray Bolz of Case has faculty *development* as its responsibility, and faculty *utilization* is the responsibility of the Educational Methods Division. The acuteness of faculty needs is still present, as evidenced by the following figures. The "counted" freshman engineering enrollment is up 3.2% over last year, reversing a two-year decrease. The total undergraduate engineering enrollment is down about 2.7%. The continued increase in M.S. and Ph.D. degrees granted is a good sign, but will it hold up as the number of B.S. graduates decreases?

► That on the campus of each member institution someone is responsible for promoting individual membership? Have you done your share to make his job easier by offering to make some personal contacts or to explain ASEE and its work to a potential member? Some schools have 75 to 100% of their faculties as members. Is yours as high as it could or should be? If it isn't, be certain it is not something to which you contribute by default.

► That the annual College-Industry Conference is at the University of Cincinnati on February 2 and 3? The program has "Professional Climate" as its theme, and the RWI Division has worked hard to promote attendance. Representatives of industry will be there. If past history repeats, there will be few educators. Too bad more deans don't attend.

► That the Technical Institute Division is undergoing an extensive reorganization in order that it can better meet the needs of technical institutes and their teaching staffs? An "Administrative Committee" is being organized with each technical institute having one or more curricula accredited by ECPD having one representative. This forms a group which can consider administrative matters in a manner similar to ECAC. The second part of the reorganization is to direct more of the activities of the Division toward academic personnel. This is being done in order that technical institute teachers can get together and talk over their problems in the same way that engineering teachers get together in the other divisions of the Society to discuss their affairs.

► That everyone connected with graduate students should know about the National Science Foundation Graduate Fellowship awards? Applicants must be citizens or nationals of the United States and have demonstrated ability and special aptitude for advanced training in the sciences and engineering. They also are required to take the graduate record examination. Students entering graduate school for the first time and those who have had less than one year of graduate study receive an annual stipend of $1800; Fellows who need one final calendar year of training for their doctoral degrees receive a stipend of $2200, and those between these two groups will receive stipends of $2000 annually. A dependency allowance of $500 per annum for spouse and for each dependent child normally will be available. Tuition, laboratory fees, and limited travel allowances also will be provided. Application material should be obtained from the Fellowship Office, National Academy of Sciences, National Research Council, 2101 Constitution Avenue, N.W., Washington 25, D. C. But don't encourage anyone to start an application now; the deadline was January 6.

► That there is a "World Wide Graduate Award Directory"? Fellowships, assistantships, prizes, scholarships, and work study plans for students and professional people are compiled and published by the Advancement and Placement Institute, Box 99, Station G, Brooklyn 22, New York. The cost is $3.00 per copy.

► That three of the 40 NSF postdoctoral fellowship awards for advanced study and research in the sciences went to engineers? Each fellow receives a stipend of $4500, an allowance for dependents, and a limited allowance to aid in defraying the cost of travel to the affiliated institution. The three in engineering selected the Imperial College of Science and Technology in England, the London School of Hygiene and Tropical Medicine in England, and the Max-Planck-Institute in Gottingen,Germany.

► That active participation in programs aiding engineering education in Pan-American countries seems to be a growing responsibility of the U. S.? A major contribution has been made by Dean Emeritus S. S. Steinberg who recently was honored by the Government of Brazil for his contribution to engineering education in that country. Dr. Steinberg has returned to the United States after having served as President of the Instituto Technologico de Aeronautica for several years. The decoration by the President of Brazil was the Order of Merit (Aeronautics) in the rank of Commander, the highest civilian award.

► That *Crusade for Education* has a section entitled, "Foreign Teaching Vacancies Available"? The coverage, however, seems to be limited. *Crusade* is published monthly except October and July by the Advancement and Placement Institute, Box 99, Station G, Brooklyn 22, New York. The cost in the U. S. is $5.00 a year.

► That the report of the U. S. IAESTE Committee for '59–'60 states, "More U. S. students could be placed if they would have a working knowledge of a foreign language"? IAESTE is the International Association for the Exchange of Students for Technical Experience. Of the 182 candidates from 52 colleges and universities, 96 students were placed, 73 of whom can be said to be in engineering. Most of the others were either in chemistry, physics, or liberal arts. The largest number of placements was in mechanical engineering, 25, and electrical engineering, 21. The number of foreign students training in the United States was 81, fifteen more than last year. U. S. companies participating in the program numbered 50, six more than last year. The interest of U. S. students in participating in the program continues to increase, but the real problem is the small number of positions which are available in the U. S. for students from abroad. The program is a reciprocal one. Copies of the report can be obtained from Joseph Wischeidt, Jr., Executive Secretary, IAESTE, at EJC headquarters.

► That EJC has authorized its Engineering Information Committee to develop a proposal for submission to the National Science Foundation for undertaking comprehensive study concerning the availability of engineering information to American educators, educational institutions, and others? NSF has been assigned the task of exploring and promoting adequate examination of scientific and engineering information. Although NSF has allocated about $500 million so far, little has been accomplished in engineering. The EJC study is intended to determine what information from foreign countries of real value is available in the U. S., and to present recommendations on how to improve the situation. About $100,000 probably will be involved.

► That the Engineering Foundation Board approved the proposal of EJC to establish an academy of engineering committee and to financially support the study? President Eric A. Walker is one of the six named to the committee chaired by W. R. Hibbard, Jr. of the GE Research Laboratory, also a member of ASEE. The Engineering Foundation acts as the research federation for the five societies (ASCE, AIME, ASME, AIEE, and AIChE) constituting the United Engineering Trustees, Incorporated. Professor A. M. Goudin of MIT is the new chairman of the Foundation.

► That the survey of the engineering profession proposed several years ago is not dead? M. D. Hooven of the Public Service Electric and Gas Company of Newark is the new committee chairman. A brief history of the project is that member societies contributed funds and the Bureau of Applied Social Research at Columbia University prepared a comprehensive statement of the project. This was then submitted to the Ford Foundation for support, but was turned down. Further planning then was deferred until EJC had completed its study of the Engineers Register Project, which resulted in a recommendation that a register not be prepared. Now the joint ECPD-EJC Committee is preparing a proposal for submission to the National Science Foundation.

► That "Financial Aid for College" is a new publication of ECPD? The "threefold" pamphlet gives information on where to look for financial aid and borrowing, and explains cooperative engineering education. It also tells where to look for additional information. The pamphlet is available from ECPD for 3¢ each for quantities under 25 and 2¢ each in quantities over 25.

► That "Citizenship and Participation in Public Affairs" is a new publication of ECPD? It stresses the engineer's responsibility to society and is the outgrowth of many years of concern on the part of major engineering societies for the younger members of the profession to take a more active part in civic responsibilities. The booklet is based on an earlier publication of ASME. "Engineers and Politics" by R. V. Wright and "Detroit Engineers Public Activities," an abstract of an article by S. M. Dean, are included. Copies may be obtained from ECPD for 25¢ each.

► That the ASEE-ANS Committee on Objective Criteria in Nuclear Engineering Education held its first meeting in late October? During the three-day meeting six sub-committees and five task forces presented reports on special assignments. The next formal meeting is scheduled for this month, at which time a preliminary report will be drafted. It will be submitted to engineering deans, heads of technical institutes and engineers in selected industries. All of the comments then will be studied and a final report should be available for presentation at the June meetings of ASEE and ANS. The work of the Committee is financed by the U. S. Atomic Energy Commission, and Glenn Murphy is Chairman of the Committee.

W. LEIGHTON COLLINS
Secretary

Ethics Has to Stick

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In the past two years we have lived in or have visited nine Asian countries. Most of these nine countries are what we call backward nations. In most of them the great majority of the people are very poor, and usually the governments themselves are poor. And in at least some of them there is, or has been, a degree of corruption and dishonesty. Corruption may not be the only reason why these nations are backward, but I am sure corruption has something to do with it.

Ours is a forward nation. We have a high standard of general ethics, and we must keep up that standard. If we let it deteriorate, we may never be able to build it up again.

We take pains to protect our integrity. Let me give you an example. A friend of mine is a contractor. His firm had bid on the underwater foundations for the towers of one of our great suspension bridges. This was a sub-contract. The principal contract had been awarded to an important, nationally known construction company. Then a prominent financial manipulator, with not too good a reputation, bought heavily into the principal contracting company. My friend immediately recalled his bid for the foundations.

And we Americans have a good reputation for integrity. A year ago my wife and I spent a week or so in the Oberoi Palace Hotel at Srinagar in Kashmir. We ran out of rupees but the manager of the hotel told us not to worry. When we paid our bill he took our personal check on a Detroit bank. He had never seen us before and knew that he never would again; he had never even heard of us. Other Americans have had the same experience in various places abroad.

Prepared by arrangement with the Chairman of the Committee on Ethics for presentation in a session sponsored by the Committee during the Annual Meeting of the American Society for Engineering Education at Purdue University in June, 1960. Recommended for publication by the Ethics Committee.

Retrogression

But possibly we are in some danger of slipping backward in ethics. There are signs of a weakening of our moral fiber. The television scandal last year shocked everybody. But it is at least reassuring that people were shocked; if we had a low standard of integrity we would not have been shocked.

Of course, television management is not engineering, nor engineering industry. But we had better look to engineering too. At the meeting of the American Society for Engineering Education at Dartmouth in 1952, John Snell, now of the Michigan Associated Engineers, apparently met with officials of the Society and confidentially pointed out to them that vicious practices were getting into some branches of the profession. As a result of what he had to say, the President of the Society appointed the Committee on Ethics.

Violations

We don't have much first hand information about violations of engineering ethics. What we have is mostly rumors and stories. But the rumors and stories must have some basis in fact. When there is quite a lot of smoke there must be at least a little fire. A few years ago this Committee on Ethics corresponded widely with prominent engineers and engineering officials in all parts of the country, and in many different fields of engineering. The letters, and a few interviews, convinced us that some or all of the following at least do happen, even if they are not common:

1. Sales engineers prevail upon customers to purchase their products when they know that the products will not exactly meet the customers' requirements.

2. Inferior engineering designs are substituted for good engineering designs in order to give a product more eye appeal or other superficial selling points.

3. Engineering employers offer higher salaries to college seniors than they pay to fully competent, older and experienced engineers.

4. Engineering firms provide free engineering surveys with the understanding that they will get the jobs if the clients go ahead with them.

5. Older and supervising engineers steal the credit for designs, inventions and ideas of younger engineers in their charge.

6. Engineers are dismissed without the slightest information as to the reasons for the dismissal.

7. High fees are paid to influential persons for "good will."

8. Illegitimate rebates, commissions, and "kick-backs" are granted.

The files of the Committee would enable me to continue this enumeration more or less indefinitely.

Now it seems to me that all this is very bad for a number of reasons. First of all, most of you will agree that these procedures violate our sense of what is proper, even if they may not be outright immoral. Second, they are dangerous because they may be the first indications of the kind of moral decay which could ultimately destroy our American vitality, as mentioned a moment ago. Third, they are bad, more emphatically, because engineers are progressively taking over more and more influence in our industries and communities, and we don't want immoral men to run our affairs for us, even if they are engineers. Finally, they are bad simply because it is bad to be improper or immoral.

Special Concern

There is a special reason why we must be concerned about professional ethics. This reason is that our engineering education processes are designed primarily to make our students technically competent. There is little in our curricula or instruction to impart ethical standards. But technical competence alone will get us nowhere. We can accept that as a principle. Hitler's Germany had technical competence of the first order. And of what use was Hitler's Germany; and where is it today? Technical competence must be protected by high standards of integrity, otherwise it is either futile or dangerous; more likely both.

How does this work out right here and now, in our American situation? Is this all speculation, theorizing and moralizing, or is there a practical application? There is. Our learned men and our philosophers tell us that engineers and technologists are taking over our affairs. We knew that, of course, before they told us. Everything we do, from morning to night, ties into engineering. The first thing we do in the morning is probably to turn on the light. Electric current is an engineering service. It comes from an engineering machine called a transformer, and more remotely from a turbogenerator. We get our breakfast out of an engineering device called a refrigerator, and we go to work in an automobile or a suburban train. I challenge any man living in a civilized community to name a single thing he does without some assist from the engineer.

Let's take a step further. Sixty years ago the ordinary engineer was a hired man. A corporation or other enterprise hired him to solve technical problems: to design a steam engine or to build a stretch of railroad. The ethical rights and wrongs of the corporation or enterprise were no concern of his; they were in the hands of his boss.

New Conditions

But the situation has changed. More and more engineers are getting into the administration of industry. For example, in *Electrical Engineering*[1] for March, 1958, F. W. Miller reports on a sample of ten industrial companies in which from 60 to 80% of executives and managers are engineers. According to *Engineering —a Creative Profession*, published by Engineers' Council for Professional Development, 34% of all engineers get into top executive jobs, and 40% of all executives are engineers.

None of this is news to you, but may I suggest certain implications? The modern engineer-executive not only has

[1] Vol. 77, No. 3, p. 205.

charge of technology in a corporation or a company, he has charge of all its affairs. Or if he is not the top official, he at least has an influence in its affairs. These affairs certainly include the integrity of the corporation, and its reputation for integrity. The engineer in administration has a responsibility in all the countless ethical questions that arise in dealing with the public, with national, state and local governments, and with suppliers, employees and customers.

For example, the engineer-executive may have to decide whether a projected dramatic advertising program tells the truth about the pumps or excavators his company makes or whether it exaggerates to the point of deceit. More difficult, he may have to decide whether or not to use in his advertising that new kind of subtle psychology you hear about which hypnotizes a man into buying something he neither needs nor wants.

The situation has changed, too, in that the American public now expects and demands of the industrial executive that he give them what may be called ethical protection. The people expect him to assume responsibility for delivering honest value and service for their money. I remember how angry I was when I learned that a certain article for which I had been paying seventy-five cents was manufactured and packed, including all fixed charges and overhead, for a little over four cents.

But sixty years ago the buying public had little ethical protection. It was *caveat emptor;* you bought what you needed, paid what you had to, and fondly hoped that you hadn't been swindled.

So the engineer-executive takes over a load of moral obligations and we have to prepare him to carry them.

Teaching Ethics

The more or less obvious conclusion is that we have to teach the student ethics. People will tell you that he should learn to know right from wrong at home, and in his church and school, and that if he hasn't, it is useless to try to teach him these things in a college of engineering. I don't seem to go along with that kind of reasoning. We are all agreed that engineering students must learn not only science and technology but humanistic-social subject matter as well. The colleges must teach them not only to be competent engineers, but likewise to be good men and responsible citizens. We are all agreed that up to 20% of the weight of the engineering curriculum should be devoted to humanistic-social instruction. Now I ask you, why should we reach into the system of humanistic-social subjects and extract from them instruction in ethics, the one thing which is probably most conducive to making them good men and responsible citizens?

In college the student should learn more about ethics, even if he has learned them at home and in school, for the same reason that we teach mathematics and physics in the colleges of engineering, even if the boy has studied those subjects in high school.

Motivation

There is one phase of this whole business which we have not considered in ASEE, as far as I can remember. That is motivation. We don't solve the problem completely by making a boy understand the difference between right and wrong. We must induce him to want to do right and to avoid what is wrong.

Picture to yourself a rather prominent engineer in one of our states. I don't know his name; indeed I don't want to know it. He was in charge of the construction of a very large building for the branch in his city of a well known American company. He connived with the contractor's superintendent, an inspector, a cost man, and one or two others to cheat on the specifications for the concrete and other materials, and they divided about forty thousand dollars between them. After some years the building developed cracks and other defects, and a board was appointed to investigate. One very intelligent and aggressive young lawyer for the board followed all the clues, and the engineer and his friends were discovered and punished.

In the course of the investigation it was disclosed that the engineer had been a brilliant student, and had completed a college course in engineering ethics with an *A* grade. Later he wrote the license board examinations in his state and came out highest of all candidates in the sec-

tion on ethics. In fact, the chairman of the examining board recommended to the dean of the state university that he give a series of lectures on engineering ethics to the undergraduate students.

This is a good illustration of an engineer who doubtless knew very well what was right and what was wrong, but was not properly motivated.

Procedure for Motivation

Now comes the real question. How can you motivate engineering students to take ethics seriously? Answers to that question must wait for other discussions. I doubt if I am competent to give the answers, but I should like to leave a few suggestions for your consideration.

First, I should think there can hardly be a more powerful motivating influence than your own impeccable deportment and attitude. Anything like favoritism or other inequality in relations with students is deadly. Students may be cynical about their faculties, but a respected professor dominates his students.

Second, you can frequently appeal to the American sense of generosity and fair play, not so much in the abstract but by using dramatic illustrations. Fair play derives from ethics, I suppose, but at the same time it is a motive for ethics. Fair play is one of the strongest American ideals or aspirations. If you can make your students realize that fair play and ethics dovetail together, you will have a good start toward motivation.

Third, there is the Golden Rule, another well known ideal for Americans. It has possibly somewhat less appeal for boys than fair play because it is not so masculine in tone, but it is a strong motive nevertheless.

Fourth, you can remind the student that the ethical and upright engineer enjoys peace of mind while the unethical and dishonest engineer is tormented by worry and fear. He always has to be sure that he is consistent in all the lies he has to tell to cover up his illegitimate operations.

Fifth, there is an appeal to religion. Ethics and religion differ widely, of course, in their bases and origin. Ethics isn't religion at all, it is philosophy. But the fact remains that the student who obeys the Ten Commandments is bound to be ethical in his deportment. The difficulty is that you don't know who of your students is religious. Figures have been published to show that there is an important resurgence of religion in the United States, but it doesn't follow as yet that you can stir the typical engineering class by an appeal to religion.

To me, religion seems to be the most potent of the motives. I remember reading in January that the late Albert Camus, French author and philosopher, had found it difficult to build up a philosophy of life without God. I am no philosopher but my answer is, don't build a philosophy of life without God; build it around God. It is as simple as that.

Sixth, you can impress your students by relating cases of the best kind of ethical behavior. I am thinking of one such case, not in the engineering profession at all. Quaid-i-Azam Mohammad Ali Jinnah was the George Washington of Pakistan. He was both a practicing lawyer and an influential member of the Assembly or Parliament. He was much concerned about a bill in the Assembly which would strongly influence the national welfare. His opponents in the Assembly prevailed upon one of his clients to retain him for an important case and to offer him a fee of 100,000 rupees. Then they scheduled a conference with Jinnah about the case on the day the bill was to be debated in the Assembly. Jinnah saw through the ruse and contemptuously turned down the case, and the 100,000 rupees.

More than Motions

The engineering teacher must be sincere about the teaching of ethics. If he goes through the motions of teaching and urging ethics, but remains cynical himself, students will soon detect his deception. You can't fool students very long. Such a teacher will get no results. Indeed he is probably being quite unethical himself. In any case, he does not belong in a professional school, and the sooner he resigns or departs otherwise, the better.

Professional Climate

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It is well in a discussion of 'Professional Climate' to have an understanding of what we mean. It is just as important to know what we do not mean. People of diverse vocations have always been concerned with the problem of their own professional status. Certainly engineers as one group have been debating the meaning of professionalism for a long time. There are innumerable committees of various engineering societies who have been attempting to define the profession. However, these definitions are often involved in such legalistic questions as registration. I do not wish to add further to the confusion on this question by adding another definition.

Climate implies environment. This too has occasioned concern. Here the emphasis has often been on the externals of environment—the physical surrounding, fringe benefits, and the like. In this it may be that the engineer has been paying too much attention to what he believes to be his due, and not enough to why he deserves some preferential treatment.

The Committee on Professional Climate of RWI Division of ASEE decided that if it is to contribute at all to this question of professional climate, it must do so in terms of the more abstract aspects of it For this reason it chose to define professional climate as "the conscious attitude of associates and management, integrated to stimulate and encourage increased intellectual capacity, moral integrity, acquisition of experience and effective application of skill and knowledge in the conduct of work, and with due regard for service to society and the enhancement of the profession."

Presented at the Annual Meeting of ASEE, June, 1960. Recommended for publication by the Relations with Industry Division.

Present Status

Let us start with a brief review of how the engineer has acquired the status he holds today. At one time, the four-year college curriculum emphasized the learning of a certain level of skill which a young man was expected to use in his first job. The fundamental principles, laws and more difficult analytic techniques were not strongly emphasized during the curriculum. His first job, as a rule, did not present the type of challenging problem that would sharpen what little knowledge he did acquire. Today, we might classify the type of activity that the typical graduate would be doing as sub-professional. In fact, the school trained the man for what may be recognized as the function of a technician today. The man who, with this background, eventually came to be the professional engineer was one who in effect had the opportunity and capacities to grow out of the ranks of his fellow technicians.

Even with considerable help from company training programs, the young engineer was expected to rise through a sub-professional stratum by demonstrating performance, imagination, vision, drive, or whatever other attributes were needed for success in the attainment of professional status. The process was such that at no point was there a clear-cut line of demarcation between the sub-professional and the professional. Even when the young man was inclined to regard engineering as a profession and not a trade, he was given little encouragement. Often as a consequence he tended to think of advancement as a transfer out of engineering and into management. Such a step normally should represent another step in the engineering scale toward professional status. This is still largely the pattern today and the idea that advancement to a managerial func-

tion is a move out of engineering still persists.

The process which I have described is essentially that of filtration. All are put into the same hopper and the "best" men are eventually filtered to the top positions. Unfortunately the filtration involves two very bad features. It is slow! It may filter out the wrong men! It has the effect of selecting, for early promotion, men who exhibit the best performance on the job. The reason such performance is best need not be related to the man's potential for ultimate leadership. There may even be a negative correlation.

The process has other effects:

(1) Education tends to be oriented to a need for the immediate post-college job.

(2) The man who is promoted on performance will, as a doer, tend again to be promoted on the same basis, with the result that he will reach the top on the strength of an excellent record for doing what is immediately needed and not on his reflection of the consequence of doing or on his ability to recognize and define the larger problems.

(3) The good man who does not progress rapidly, who does not achieve a professional engineering status, tends to become discouraged with the profession. He becomes frustrated. His attitude, which is the antithesis of professional, tends to influence younger fellows coming into the field. This may be a factor contributing to the feeling of a need for unionization of engineers.

(4) The emphasis on engineering as a profession, which at the same time includes the functions of the technician, tends not to produce qualified technicians who will recognize their role as such.

These remarks seem to imply that engineers need a special treatment, that they should be singled out and given certain preferences. They should be nurtured in a special environment—"professional climate." This thought is usually implicit in all discussions on professionalism. Often it takes the form that engineers are entitled to such preference. No one answers the question, "Why are they entitled to it?"

Let us examine this question further. It seems to me that any review of the problem of professional climate must first recognize the needs of the total society and not just of a special group. Engineers will not be professional, industry will not provide a "professional climate," unless there is a demonstrated need to do it, and unless such need can be demonstrated in terms of distinct advantage, not just to the engineer, but also to the society in which he must function, and to the company which employs him.

Engineers may be looked upon as performing certain necessary functions. Since these functions are provided to the total society by relatively few people, society will tend to purchase the service in terms of the most economical solution to the problem to be solved, and in terms of the supply of the people available to do it. The group should not be given any special privileges or advantages, except to the extent that by so doing, an overall social gain is realized. Thus a company will provide extra benefits, will be concerned about employee morale, not because of intrinsic interest in the employee, but because by so doing, it will come to realize a greater gain from the efforts of that employee. This is just good "employee relations." What applies to a bricklayer applies in a similar way to an engineer, or to a draftsman. Therefore, is perhaps this question of "professional climate" just one of job or employee relations? It is to the extent that it tends to provide an optimum system for maximizing some output, but it is different in that the output is different. The compensation for any non-professional type of activity is one for a performance which is measurable. There is an output which can be seen and which can be measured in terms of time spent, pieces produced, etc. Rewards in turn can be geared to the output. This certainly applies to a bricklayer. It applies in most respects to the output of the draftsman. It applies also to the routine design output of most engineering activities.

On the other hand, the effectiveness of planning and designing complex systems, of weighing their impact on the company and on the social structure into which the company fits, and all else that

is implied by it, cannot be measured in terms of any convenient, simple parameters. Furthermore, the tangible reward that the man receives for this type of endeavor will in no way compare with the contribution that he makes, or perhaps fails to make. The results in the long run depend on the imagination that has been used, the degree of responsibility that has been involved and the overall judgment which has been brought to bear on the problem. And perhaps significant is the degree to which the man identifies *his* own personal objectives with some overall objective which is unrelated to his personal material gain. His contribution, if measurable at all, is estimated on a scale which is unrelated to his material rewards.

The Attitude of a Professional Man

Of the various attributes which typify a professional engineer, that of attitude is most significant—an attitude which includes the ethical and moral viewpoint, a social consciousness or awareness of how his acts affect society, and an acceptance of the responsibility inherent in his action. In short, he is *dedicated.*

This attitude can develop only in a climate or environment which stimulates it. Attitude is not taught in a course. It is not acquired by passing the professional engineering examination. It develops over the entire span of his life.

In reviewing the question of professional climate, let us take a moment to look at it from the point of view of other attributes which are conceded to be significant in the professional engineer. Highly developed knowledge and skill is one. It is on this that emphasis is placed during the college career. In fact, almost the whole emphasis is placed on acquiring it rather than on using it. In industry, on the other hand, the man is called upon to employ his knowledge to achieve specific goals. At the same time his level of knowledge cannot remain static—he must continue to increase it. Hence the conditions of the job should be such as to provide this opportunity. Of course, it is impossible in any engineering job situation not to increase knowledge, for the simple reason that the problem invariably demands it. However, he can either call upon others to assist him in the areas in which he is lacking, or he can set out to acquire the knowledge himself. This involves a rather fine balance as to when he, on his own responsibility, should devote more time to learning as opposed to calling on someone else for help. The man himself is in the best position to make a subjective assessment of his optimum course of action as demanded by the situation. Therefore, the environment in which he operates should be such as to afford him the prerogative of making the decision and the opportunity for implementing it after he has made it.

An important attribute of the professional man is the one which tends to let him see a problem clearly, without bias operating for his own material gain. Consequently, an important aspect in a professional climate is a high income. Let us face it, whether we like it or not, our society does associate status with money. Thus, the income which relieves some of the pressure for material gain is essential to the development of the attitude which de-emphasizes personal material reward.

Another essential attribute of the professional man is recognition of diverse responsibilities—responsibilities to the employer, to the professional group and to society as a whole. Thus, it is necessary that the organization within which he works encourage acceptance of responsibility and at the same time recognize the man's need to identify the various responsibilities himself.

Of course it may be argued that such privileges simply could not be granted to the large numbers of engineers in an industrial concern. The company just could not afford it. This may be true, but the answer is that most present engineering functions are not professional in scope. They are in the nature of production operations. I contend that only a small percentage of what is commonly classified as engineering falls within a professional scope. Therefore the need may be to delineate more carefully the sub-professional functions, recognize them for what they are and concentrate on the development of a relatively few professional engineers. This would mean that a select group be identified at an early stage in their careers. The men

who are chosen should then be pushed as rapidly as possible to the top. An apprenticeship program requiring experience in sub-professional tasks should be replaced with what we might think of as an internship. In short, once a man is identified for eventual professional status, he should always remain in the environment conducive to professional growth.

It must be made clear, at this point, that our objective should not be one of developing a small, exclusive group at the expense of others, but rather it should be a part of an overall objective of raising the status of all men. Our technology has made it possible for the man that at one time might have been a farm hand to become a mechanic, the mechanic to become an engineer. The problem which is now urgently confronting us is a further rapid up-grading of function in terms of complexity of the jobs, and the training or the education required to fit the people to them. Too often the words *technician* and *sub-professional* imply a down-grading. This could not be more wrong. The technician must be up-graded. The training he had in a two-year technical institute may need to be extended to four years. Along with this it is important that general education be extended for the overall betterment of society.

However, corollary to this up-grading of people is a down-grading of function. This is self-evident. We have seen it occur in drafting and in surveying and in other activities which were once considered primary functions of the engineer. We tend to forget the resistance which such down-grading met. Many of us now may be guilty of generating resistance to further necessary down-grading of function by confusing it with a down-grading of people.

I believe that the up-grading of engineers must be accompanied by an extension of education. Where and how this added education is to be obtained is not clear at present. Certainly some must come from formalized university programs. Whether it will come about by extending the schooling time or by making the present curricula more efficient is not fully evident. However, I suggest that it may come about by means of a graduate professional education as in medicine and law. Some and perhaps the most significant part of the education must and will come as a consequence of the job situation. However, it is not within the scope of this paper to discuss this aspect of the problem. It is my purpose to discuss the question of professional climate. I believe that this is the most significant aspect of up-grading the engineer.

Providing Professional Climate

Therefore, let us get down to specifics. What can we do to provide professional climate? We do not now have the external symbols of the professional groups of law and medicine. These symbols are high income, a ritual of behavior before the public, a formal admission to a closely controlled group, a clear identity as a member of that group starting in school. Also, we must start from where we are now. We do not have the 'conscious attitude' as professors, as supervisors, or as employers which is referred to in the definition of professional climate, which was stated at the outset.

In many cases the external trappings are incidental but nevertheless important for the stimulation of a professional attitude. Certainly we should work toward providing better offices and physical environments on the job and for the other outward marks of distinction. On the other hand, these may come as a natural and inevitable reward for professional stature.

The other less tangible aspect of professional climate is hardest to grasp, to delineate, and to describe to others. Yet it is the one on which we can work most profitably. The work is a missionary one. We must first examine our own attitudes and behavior, with respect to our jobs, to our students, to our colleagues and to others. Being convinced ourselves, we will act in a way to induce others to emulate us. Continual attention and discussion directed toward the question of a professional attitude will in the long run have its effects.

Of all the environments where the introduction of a stimulus to develop professional climate is needed, that of the engineering school is the most important. It is during the four undergraduate years that a basis for professional attitudes can

be formed. Therefore it is the university which should assume leadership. It is in the university environment that the student should begin to look upon himself as someone slated for a unique role in society. He should begin to realize that his position will grant him special privileges—a higher income than others, respect of the community, and so forth. But it will also make special demands on him. He must commit himself to live up to a high set of ideals. His conduct must be exemplary. He must be *dedicated.*

If we can be successful in inculcating in him a professional attitude while in school then it becomes imperative that a similar climate be maintained during his first few years in industry. If he continues to identify himself with a special group with special responsibilities, his professional attitude will continue to be strengthened during these years. His attitude will not be enhanced by requiring him to do a routine job with the same status as other technicians. He should regard his early job experience as part of his professional education—as his internship.

During this internship the young engineer must both learn and produce. There undoubtedly is an optimum ratio of these two activities which I suspect we have not reached. The optimum must be realized in terms of maximum contribution over a total life time. Since the output of the professional man will be at a much higher rate than others, it follows that the time to build him up to his maximum rate of output should be as short as possible. Thus it may be argued that the establishment of a climate that tends to make him, his associates, his supervisors, and the public aware that he has been singled out will accelerate his progress and justify the process from an economic point of view. I contend that it will be the overall pay-off to society that justifies industry's concern with fostering "professional climate." The engineer must emphasize the pay-off—by his *service,* not by reward to himself.

Advanced Professional Education

Finally a word is indicated on the question of advanced education of the professional engineer. It should be evident that a four year formal course does not make a professional engineer in terms of either technical competence or professional stature. The man who now acquires professional status goes far beyond the four year graduate, but does so on his own. It may be that the time has come to re-examine our total educational pattern in engineering and endeavor to assess what functions may be better undertaken in and by industry, and what is better accomplished in and by the university. We should think of a graduate professional education for the creation of a new "image of the engineer."

To recapitulate what I have endeavored to say in the foregoing paragraphs:

A professional man is a dedicated man; he recognizes and accepts a responsibility with respect to his job, his employer, his community and society at large which sets him apart from others.

The attitude of the engineer, which marks him as professional, has been developed in the past by those who have risen above their fellow technicians. A professional attitude will grow and develop more quickly in a climate which is conducive to it, and such a climate should be consciously engendered in the school and maintained in the early industrial job situations.

A relatively small number of students should be selected to be professional engineers. These men should be given special treatment to develop their full capacities as rapidly as possible. This will require the maintenance of their special professional identity. These privileges are economically justified by the promise of the man's correspondingly greater contribution.

The plan is one of raising the status of all men, both with respect to function and with respect to attitude. But, as more people come into technical fields, which were once the province of the engineer, it becomes important that the ever small number of creative leaders be specially singled out and assisted in developing their maximum potential for contributing to society. The engineer must repeatedly emphasize the service he offers, not the rewards he wants.

Kentucky—Host to ASEE in 1961

69th Annual Meeting of ASEE, University of Kentucky, June 26–30

Rich in American frontier history, Kentucky after 169 years of legal existence maintains the spirit, drive and perseverance which led to statehood in 1792.

The pioneering influence of such forefathers as Daniel Boone, John Bradford, John C. Breckinridge, Isaac Shelby, Henry Clay and others is evident today as the state builds on its agricultural base toward greatness in industry, business, education, power resources and transportation.

Kentucky is on the move in all these fields, discontent with the status quo, happy to preserve vestiges of its colorful history but anxious to extend economic hands of friendship from its resourceful storehouse of mountains and valleys, coal, oil and gas fields, miles of navigable streams and a diversified agriculture.

Not the least of Kentucky's assets is the state university at Lexington in the famous Blue Grass section. Visitors to the ASEE annual meeting there in June will be aware of the university's physical and academic growth, and through association with "Kentucky folk" will become innoculated with another of the state's strongest resources—hospitality.

Original inhabitants were somewhat lacking in this resource. The Red Men of many tribes, including Cherokee, Creek, Catawba, Chickasaw, Iroquois, Wyandotte and Shawnee, fought each other and the intruding white man with equal savagery as the pioneering spirit sought to extend the frontier.

The white man was not to be denied, however, and from a frontier trading post and fort was organized in 1779 the first Kentucky town of Boonesborough. An initial settlement at Lexington (named for the Revolutionary War battle of Lexington) was made the same year by Robert Patterson and 25 companions. It became a town in 1781.

Blue Grass society rapidly absorbed elements of eastern culture and immigration to this section brought with it the Englishman's fondness for horses. In 1789 the first race course was established at Lexington and organized racing became one of the three boastful state symbols that have existed to today—whiskey, pretty women, and fast horses.

But, Kentucky offers much more.

Agriculturally, it is the leading producer of burley tobacco with the world's largest loose-leaf tobacco market at Lexington. Cash receipts from this one crop totaled $220,144,000 in 1959. Receipts from corn, wheat, hay, cotton lint, Blue Grass seed, fruits and nuts, greenhouse and nursery products and forest products totaled another $63,000,000.

Cash receipts from livestock and livestock products for 1959 totaled $287,-167,000 slightly more than half of the $570,688,000 from all commodities.

These figures represent cash sales only and do not include the value of farm and home consumption. A year earlier, in 1958, total income from agriculture and related business (sometimes called 'Agribusiness') was estimated at $1,807,-000,000 (billion).

In 1959, there were 187,000 farms in the state with an estimated 198,000 family workers and an average of 46,000 hired workers.

Since World War II, economic emphasis has been on industrial expansion and in Kentucky such expansion has exceeded by 43 per cent the national expansion. During this time, machinery manufacturing has risen 601.5 per cent; chemical manufacturing is up 317.8 per cent, and electrical machinery manufacturing is up 411.1 per cent. Total Kentucky manufacturing is up 135.1 per cent compared to 94.5 per cent for the United States as a whole, according to the U. S. Chamber of Commerce.

There are about 3,000 manufacturing establishments in the state employing some 170,000 people. The firms run the gamut of diversification from coal mining and steel manufacturing plants in the east, through tobacco, whiskey, automo-

bile, electronic equipment and appliance making in Central Kentucky to the chemical, atomic energy, power producing and rubber manufacturing plants in the Western part of the state.

A few factors behind this manufacturing complex are the state's central location between North, East and South; more miles of navigable streams than any other state; reserves of electric power with this resource increasing at a rapid rate; deposits of coal, oil and clays; and agricultural, timber and woodworking resources.

Mineral production in Kentucky was $402,121,000 in 1958 with coal production ranking third in the United States. The 66,312,000 tons had an estimated value of $289,385,000.

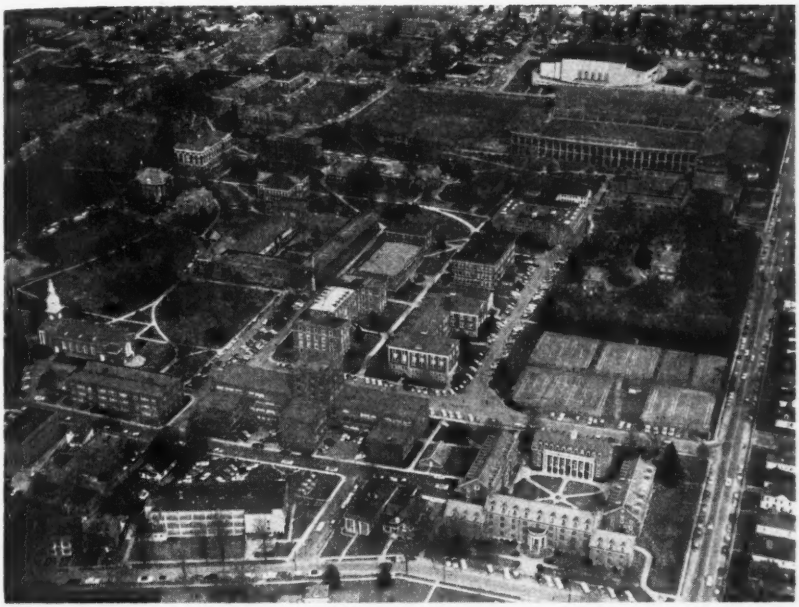
Other mineral resources include petroleum (17,509,000 barrels valued at $51,542,000 in 1958), natural gas, limestone, fluorspar, refractory ball and common clays, glass sands, construction sand and gravels, rock asphalt, iron, zinc and lead.

Although emphasis since 1947 has been on industrial expansion, recreation has not been neglected. Tourism is fast becoming a major income source in the state. ASEE visitors will have access to 34 state parks, many with modern lodging and reasonable rates. They are dotted throughout the state from the vast water playground area of Kentucky Lake in Western Kentucky to the picturesque mountain retreat at Cumberland Falls near Corbin. In addition are numerous historical sites, many of them in the 22-county Blue Grass region and within easy driving distance of Lexington. Mammoth Cave, of course, is nationally famous.

Of particular interest in Lexington are the preserved homes of Henry Clay, Mary Todd Lincoln, General John Hunt Morgan and James Lane Allen. At nearby Bardstown is Federal Hill, inspiration for Stephen Foster's immortal "My Old Kentucky Home" and other music.

Lexington, itself, is the second largest

SEAT OF GOVERNMENT—Described by architects as one of the most beautiful state capitol buildings in the United States, the Kentucky Capitol is at Frankfort, 20 miles from Lexington.



FROM ON HIGH—Aerial view showing portion of University of Kentucky campus at Lexington.

metropolitan area of the state, with a county population of some 120,000 persons. The city occupies a thousand-foot plateau, has warm days and cool nights, and soil and water rich in limestone and phosphate. Besides its race horse and tobacco fame, the city is the cultural, educational, medical, commercial and industrial metropolis of the eastern half of Kentucky.

Despite its modern aspects, life on the side roads and country lanes is leisurely. Here are large old homes with an air of family living, remains of slave cabins and slave-built stone fences, covered wooden bridges spanning shaded streams and old water mills.

Lake Cumberland, Herrington Lake and the Kentucky River, in easy reach of Lexington, provide fishing, boating, swimming, water skiing and camping. Horse races, fox hunting, pony clubs and horse shows are favored in Lexington and the University of Kentucky offers conference football, baseball and basketball.

Here also is Transylvania College, oldest institution of higher learning west of the Alleghenies; The College of the Bible, several denominational seminaries and business colleges.

Lexington has one of the largest Community Concert Associations with approximately 12,000 members. There is a community symphony orchestra, a noted Youth Symphony Orchestra and several little theatre groups.

By air, Lexington's Blue Grass field is served by Eastern, Delta and Piedmont airlines. By land, U. S. Highways 25, 27, 60, 68, and 421 criss-cross the city, Interstate Highways 64 and 75 will intersect near the city. By rail, visitors may travel via the Chesapeake & Ohio, Louisville & Nashville, and Southern.

Proof of Lexington's favored position as a convention site is the 90–100 meetings held there each year. Kentucky's 3,000,000 residents join with Lexington and the University of Kentucky in welcoming ASEE visitors into the borders of what once was called a "dark and bloody ground."

Fifth Compilation of

Programs for Employing Faculty Members in Industry, Summer, 1961

Compiled by the Relations with Industry Division of the ASEE *

Engineering education and practice can continue rapid progress only if there is sufficient communication and mutual support. As one channel through which common problems can be explored and ideas exchanged, the RWI division of ASEE encourages summer employment of college faculty members in industry.

The compilation presented here gives the names of many of the companies which offer summer employment of a technical nature to college faculty members. The name of the individual to whom applications should be addressed is also given.

An increasing number of organizations make an effort through special seminars, tours and such "extra-curricular" activities to give summer-hire professors an overall picture of the operations, interests and policies of the company in addition to specific work experience. These are summarized in Part I of the compilation.

In companies where the number of summer openings is small or for some other reason special organized activities are impractical, the faculty members employed are encouraged to acquaint themselves on their own initiative with the broader aspects of company operation and policy than are involved in their individual work assignments. Entries under Part II are in this category.

Employment opportunities thus publicized are always subject to accurate matching of the assignments available with the qualifications of applicants, and depend as well on the economic position of each company by June 1961. Unfortunately, prediction of both economic factors and project requirements nine months in advance, as publication procedures require, is always difficult.

The present list does not include all opportunities available. It is limited to private corporations which hold industrial membership in ASEE and to government agencies. Several otherwise eligible organizations fill their summer positions readily without the additional publicity provided through the ASEE and are therefore not included here. It is encouraging to note that in spite of deletions of a few such listings, the number of opportunities offered through this compilation has increased steadily at a rate of about 10% per year during the five years since its conception.

Comments and supplementary or new information pertaining to this compilation should be addressed to C. E. Work, Michigan College of Mining & Technology, Houghton, Michigan.

Part I. Formal Programs

Key to Symbols Used in Compilation Columns 4–7

4. Number of Seminars
   Conferences to acquaint professors with various aspects of company policy, facilities, activities, etc.
5. Other Activities
   - U tours of facilities
   - V social and recreation
   - W luncheons etc. with company personnel

6. Basis for Payment
   - S college salary rate
   - Q Job assignment and qualifications
   - R honorarium or fixed stipend

7. Other Allowances
   - T travel
   - F food
   - H housing
   - C cost of living

PART I. FORMAL PROGRAMS

Company (Name and Address)	Contact (Person and Position)	1 Backgrounds Included	2 Length, Weeks	3 Number of Participants	4 Number of Seminars	5 Other Activities	6 Basis for Payment	7 Other Allowances
Allison Division General Motors Corporation Indianapolis 6, Indiana	V. A. Rhodes General Supervisor Salaried Personnel	Tech.	8–12	4–12	4	W	S	T
Babcock & Wilcox Co. 161 E. 42nd Street New York 17, New York	J. W. Andeen Manager Student Training Staff Division	Tech.	8–12	8–12	2	U, W	S	T, C
Boeing Airplane Company Seattle 24, Washington (Wichita, Kansas)	Fred Huleen Director of Personnel	Tech.	9–12	50	8	U, V, W	S	T, H
California Research Corp. 200 Bush Street San Francisco 4, California	D. P. Krotz Corporate Secretary and Business Manager	Tech.	8–12	2–5	—	U	Q	T
Convair, Division of General Dynamics Corp. P.O. Box 1950 San Diego 12, California (Also divisions at Pomona, Calif. and Fort Worth, Texas)	H. T. Brooks Employment Administrator	Tech.	8–12	15–50	2–5	U, V, W	Q	T
Detroit Edison Company 2000 Second Avenue Detroit 26, Michigan	George A. Sold Supervising Personnel Asst., Employment & Personnel Research Dept.	Tech.	8–12	8–10	1	U, W	S	—
Diamond Alkali Company Union Commercial Bldg. Cleveland 14, Ohio	Glenn H. Varney, Mgr. Employee Recruiting & Management Development	Chem. Chem.E.	8–12	2–5	—	U, W	S	—

PART I. FORMAL PROGRAMS—*Continued*

Company (Name and Address)	Contact (Person and Position)	1 Backgrounds Included	2 Length, Weeks	3 Number of Participants	4 Number of Seminars	5 Other Activities	6 Basis for Payment	7 Other Allowances
Douglas Aircraft Company Santa Monica, California	C. C. LaVene Employment Manager Engineering Division	Tech.	10*	10–20	—	U	Q	T
Dow Chemical Company Midland, Michigan	Leo E. Streeter Manager of Technical Placement	Chem. Chem.E.	10–12	3–5	4	U, V, W	S	T
Hughes Aircraft Company Culver City, California	Leonard C. Silvern Corporate Educational Relations	Tech.	12	50	57	U, V, W	S	T, F, H
Humble Oil and Refining Co. Humble Division Humble Building Houston 1, Texas	A. Ross Rommel, Head Personnel Placement & Services Division Employee Relations Dept.	Tech. Non-Tech.	10–12	20	3	U, V	Q	T, H
International Business Machine Corporation 590 Madison Avenue New York 22, New York	S. L. Coyne Manager, College Relations, Engineering	Tech.	8–10	20–30	7	U, V, W	Q	T
Lockheed Aircraft Corporation Missiles and Space Division Sunnyvale, California	G. Gilman Special Programs Administrator	Tech.	8–12	20–30	3–5	U, V, W	Q	T
The Martin Company Orlando, Florida	W. J. Powell, Jr. College Relations	Tech.	8–12	10–15	5	U, W	S	T
McDonnell Aircraft Municipal Airport St. Louis 3, Missouri	C. J. O'Toole Employment Manager	Tech.	12+	10–15	4	U, W	S	C

* In order to obtain clearance, early application is required.

PART I. FORMAL PROGRAMS—*Continued*

Municipal Airport St. Louis 3, Missouri	Employment Manager							

* In order to obtain clearance, early application is required.

PART I. FORMAL PROGRAMS—*Continued*

Company (Name and Address)	Contact (Person and Position)	1 Backgrounds Included	2 Length, Weeks	3 Number of Participants	4 Number of Seminars	5 Other Activities	6 Basis for Payment	7 Other Allowances
Minneapolis-Honeywell Regulator Company Minneapolis 8, Minnesota	Lachlan Reed Director, Industry-Education Relations	Tech.	8–14	5–20	5–10	U, W	S	T
Minnesota Mining & Manufacturing Company Saint Paul 6, Minnesota	Wendel W. Burton Employment Manager 900 Bush Avenue	Tech.	8–10	5–6	1	U, V, W	S	T
Pratt & Whitney Aircraft East Hartford, Connecticut	Thomas K. Fogler Engineering Department	Tech.	8–12*	20	6	U, V	S, Q	T
Public Service Electric and Gas Company 80 Park Place Newark 1, New Jersey	Clyde C. Ruffle Senior Staff Asst. Electric Department	Tech.	8–12	5	4	U, W	Q	—
Radio Corporation of America Camden 2, New Jersey	Donald M. Cook, Mgr. College Relations	Tech.	8–12	8–10	—	U, W	S	T
Sandia Corporation Sandia Base Albuquerque, N. M.	R. W. De Vore, Mgr. Employment, Personnel Testing and Staff Functions Dept.	Tech.	10–12*	25–35	—	U, W	Q	T
Standard Oil Company (Ind.) Research Department Box 421 Whiting, Indiana	E. W. Adams Administrative Director Whiting Laboratories	Tech.	8–12	5–6	3	U, V, W	Q	T
Sun Oil Company Research & Engineering Dept. Marcus Hook, Pa.	Robert A. Matteson Coordinator Technical Recruiting	Tech.†	8–12	2–5	4–6	U, V	Q	—

† Only applicants from the area near the company's operation are considered for summer employment.

PART I. FORMAL PROGRAMS—*Continued*

Company (Name and Address)	Contact (Person and Position)	1 Backgrounds Included	2 Length, Weeks	3 Number of Participants	4 Number of Seminars	5 Other Activities	6 Basis for Payment	7 Other Allowances
Texas Instruments Inc. P.O. Box 1079 Dallas, Texas	W. T. Hudson Manpower Director Staff Division	Tech.	6–12	10–25	1	U, V, W	Q	T
U. S. Army Chemical Center & Chemical Corps Material Command Army Chemical Center, Md.	Marion C. Sedberry, Chief Civilian Personnel Division	Tech.	8–14*	10–15	—	U, V, W	Q	—
U. S. Army Ordnance Aberdeen Proving Ground Maryland	Civilian Personnel Officer	Tech.	8–12*	50–100	—	U	Q	—
U. S. Bureau of Reclamation Washington 25, D. C.	A. R. Golzé Assistant Commissioner	Tech.	8–12	15–20	—	U	Q	—
U. S. Naval Ordnance Test Station China Lake, California	R. C. Nelligan, Head Recruitment Branch (code 6521) Personnel & Community Relations Department	Tech.	12–14*	35	5–10	U, V, W	Q	—
U. S. Naval Research Laboratory Washington 25, D. C.	C. N. Mason, Jr. Head, Employment Branch Personnel Division	Tech.	8–12	10–15	—	U, V, W	Q	—
U. S. Navy Electronics Laboratory San Diego 52, California	W. B. Lockwood, Head Personnel Operations Staff	Tech.	4–14*	5–12	6	U	Q	—
U. S. Navy Underwater Sound Laboratory Fort Trumbull New London, Connecticut	Miss Helen G. McCabe Industrial Relations Officer	Tech. Non-Tech.	12–14	5–7	3–6	U	Q	—

U.S. Navy Underwater Sound Laboratory Fort Trumbull New London, Connecticut	Miss Helen G. McCabe Industrial Relations Officer	Tech. Non-Tech.	12–14	5–7	5–6	U	Q	—

PART I. FORMAL PROGRAMS—*Continued*

		1	2	3	4	5	6	7
Company (Name and Address)	Contact (Person and Position)	Backgrounds Included	Length, Weeks	Number of Participants	Number of Seminars	Other Activities	Basis for Payment	Other Allowances
U. S. Steel Corporation 525 William Penn Place Pittsburgh 30, Pennsylvania	C. D. Feight Director of Employment	Tech.	9	10–20	9	U, V, W	S	T
Western Electric Company 195 Broadway New York 7, New York	E. J. Roach Coordinator of College Relations	Tech.	8–12	10–20	3	U, W	Q	—
Westinghouse Electric Corporation East Pittsburgh, Pennsylvania	R. Craig Fabian, Supv. Educational Programs	Tech. Non-Tech.	10–14	10–20	1	U, V, W	R	T

Part II. Informal Employment

Company	*Contact*
Allis Chalmers Manufacturing Company Box 512, Milwaukee 1, Wisconsin	Paul A. Bierwagen, Supv., Graduate Studies Graduate Training Department
Aluminum Company of America Pittsburgh 19, Pennsylvania	W. J. O'Hare Manager, College Recruitment
American Viscose Corporation (1–3) 1617 Pennsylvania Boulevard Philadelphia 3, Pennsylvania	William M. Nolan Recruitment Manager
Argonne National Laboratory 9700 South Cass Avenue Argonne, Illinois	C. E. Rickleff Professional Placement Manager
Bendix Corporation † * Fisher Building Detroit 2, Michigan	A. A. Canfield, Director University & Scientific Relations
Bethlehem Steel Company ** Bethlehem, Pennsylvania	A. M. Rupkey Manager of Personnel
Canadair, Limited * (1–3) P.O. Box 6087, Montreal, P.Q. Canada	A. C. Holden Engineering Services Supervisor
Caterpillar Tractor Company (1–3) Peoria, Illinois	M. D. MacLean Supervisor, College Relations
Charleston Naval Shipyard U. S. Naval Base Charleston, South Carolina	Mr. W. H. Middlemas Head, Employment Division Industrial Relations Office
Chemstrand Corporation (1–5) Decatur, Alabama	A. D. Preston Technical Personnel Manager
Chicago Bridge and Iron Company *** 1305 W. 105th Street Chicago 43, Illinois	I. E. Boberg Vice President and Chief Engineer
Cleveland Electric Illuminating Co. (1–3) P.O. Box 5000 Cleveland 1, Ohio	J. P. Flemming College Relations Representative
Continental Oil Company P.O. Box 2197 Houston 1, Texas	Marvin W. Crowe, Director Personnel Development Industrial Relations Department
David Taylor Model Basin (5–10) † Washington 7, D. C.	S. Di Maria Personnel Officer
E. I. du Pont de Nemours & Co. (10–15) Wilmington 98, Delaware	J. W. Reynard, Manager College Relations Section Employee Relations Department

* Only applicants from the area near the company's operations are considered for summer employment.

** Employment available commensurate with rate of operation.

*** Especially interested in Mechanical Engineers.

† In order to obtain clearance, early application is required.

Company	*Contact*
Esso Research and Engineering Company (3–5) P.O. Box 175, Linden, New Jersey	F. Senkowsky, Jr., Director Employee Relations
Ex-Cell-O Corporation (6–10) P.O. Box 386 Detroit 32, Michigan	C. Edward Schumacher Training Manager
Food Machinery & Chemical Corporation Chemical Division (2–5) 161 E. 42nd St., New York 17, N. Y.	A. J. St. Louis Recruitment Manager
Ford Motor Company (15–25) 2000 Rotunda Dr., P.O. Box 2053 Dearborn, Michigan	Wilson A. Jones, Manager Industrial Relations Engineering and Research Staff
General Atomic Division of General Dynamics Corp. P.O. Box 608 San Diego 12, California	Henry Anthony Manager of Employment
General Electric Company (60–100) One River Road Schenectady 5, New York (and others)	W. Scott Hill Manager, Engineering Recruiting Engineering Personnel Service
Hamilton Standard Division (4–8) United Aircraft Corporation Windsor Locks, Connecticut	W. E. Diefenderfer Engineering Manager
International Harvester Company (2–5) 180 North Michigan Avenue Chicago, Illinois	J. C. Shaw, Supervisor College Recruitment Education & Personnel Department
International Paper Company (2–4) Southern Kraft Division Mobile 9, Alabama	Dock F. Black, Jr. Director of Technical Personnel
Jones & Laughlin Steel Corporation 3 Gateway Center Pittsburgh 30, Pennsylvania	W. L. Witney, Director of Organizational Planning
Marquardt Aircraft Company (4–6) 16555 Saticoy Street Van Nuys, California	Don J. Colvin Recruitment Supervisor
Monsanto Chemical Company (2–5) 800 N. Lindburg Boulevard St. Louis 66, Missouri	Robert F. McCoole Technical Personnel Manager
Norden Division (5) United Aircraft Corporation Stamford, Connecticut (and others)	Thomas J. White Personnel Manager
Northern Illinois Gas Company (1–3) 615 Eastern Avenue Bellwood, Illinois	C. L. Wredling, Supervisor Management Development
Pacific Missile Range Point Mugu, California	Mr. Norman Newcomb Industrial Relations Officer
Philadelphia Electric Company (2–3) 900 Sansom Street Philadelphia, Pennsylvania	G. W. Kaufmann, Jr. Director, Employment Division

Company	*Contact*
Philco Corporation (10–15) Philadelphia 34, Pennsylvania (Philadelphia and San Francisco areas)	Robert T. Love College Relations Administrator
Phillips Petroleum Company Bartlesville, Oklahoma	D. R. McKeithan, Director Technical Manpower Division
Port of New York Authority 111 8th Avenue New York 11, N. Y.	John Allyn Personnel Department
Pure Oil Company * 35 East Wacker Drive Chicago, Illinois	J. J. Stadtherr Training Director
Ramo-Wooldridge Division of Thompson Ramo Wooldridge Inc. 8433 Fallbrook Avenue Canoga Park, California	Theodore Coburn Technical Staff Placement
Raytheon Manufacturing Company 1360 Soldiers' Field Road Brighton 35, Massachusetts (and others)	John B. Whitla College Relations Administrator
Republic Steel Corporation (10–15) Cleveland 1, Ohio (and other locations)	E. J. Magee Director of Industrial Relations
Research and Advanced Development Division Avco Corporation 201 Lowell Street Wilmington, Mass.	E. W. Stupack Manager Personnel Relations
Rohm & Haas Company (1–2) Philadelphia, Pennsylvania	Dr. J. S. Strong Office of Technical Employment 5000 Richmond Street
Scott Paper Company (1–3) Chester, Pennsylvania	Richard B. Miller Manager of Corporate Employment
South Carolina Electric & Gas Co. Post Office Box 390 Columbia, South Carolina	Allan C. Mustard Vice President
Sperry Gyroscope Company Division of Sperry Rand Corporation Great Neck, New York	R. T. Hamlett, Director of Employment and Personnel Services
Sylvania Electric Products, Inc. 1740 Broadway, New York 19, N. Y.	Harris Reinhardt Manager, Organization Development
Toledo Edison Company * (2–3) Toledo, Ohio	Frank W. Keith Director of Personnel
Underwater Explosives Division Norfolk Naval Shipyard Portsmouth, Virginia	H. L. Gray Head, Employment Division Norfolk Naval Shipyard
United Aircraft Corporation (3–5) Missiles and Space Systems Division East Hartford 8, Connecticut	John W. North Engineering Department

Company	*Contact*
United Aircraft Corporation Research Department (1–5) East Hartford, Connecticut	John G. Lee Director of Research
U. S. Army Engineer District † (1–2) P.O. Box 1027 Detroit 31, Michigan	W. L. Cooper, Chief Civilian Personnel Branch
U. S. Naval Air Material Center Naval Base Philadelphia 12, Pennsylvania	Mr. Joseph Haydt Industrial Relations Officer
U. S. Naval Air Test Center Patuxent River, Maryland	R. B. Henderson Employment Superintendent
U. S. Naval Avionics Facility Indianapolis, Indiana	Frank Spreen Industrial Relations Officer
U. S. Naval Boiler and Turbine Laboratory Naval Base Philadelphia 12, Pennsylvania	J. M. Lipson, Head Administrative Department
U. S. Naval Engineering Experiment Station (1–2) Annapolis, Maryland	Wilford E. Snyder Industrial Relations Officer
U. S. Naval Ordnance Laboratory † (10–15) White Oak Silver Spring, Maryland	W. B. Wilkinson Employment Officer
U. S. Naval Radiological Defense Laboratory (10–15) San Francisco 24, California	Joseph Zukor Employment Officer
U. S. Naval Weapons Laboratory Dahlgren, Virginia	Fred Harmon Employment Superintendent
U. S. Navy Mine Defense Laboratory Panama City, Florida	E. T. Castleberry, Sr. Civilian Personnel Officer
United States Rubber Company * 1230 Avenue of the Americas New York 20, New York	L. W. Armon Assistant Manager of Personnel
Upjohn Company (2–3) Kalamazoo, Michigan	Gordon L. Dolbee Technical Employment Coordinator

OFFICERS NOMINATED FOR 1961–62

Dean Curtis L. Wilson of the Missouri School of Mines and Metallurgy was nominated for Vice President of General Divisions and Committees by ASEE's Nominating Committee last November 16. In the December issue of the JOURNAL he was incorrectly reported to have been nominated for Vice President for sections west of the Mississippi River.

Understanding the Learner

FRANK L. PARKS

Professor of Sociology
Oregon State College

The preceding two speakers dealt with the topics of "Understanding the Academic World" and "Understanding the Elements of Effective Teaching." Thus we began with a consideration of the importance in the overall development of a young engineering teacher of a general knowledge of the academic world of which he is a young citizen–its history, purposes, scope, organization, etc. Then in the second paper we concentrated our attention on the principal activity in which young faculty members engage–teaching, and discussed the development of the young teacher in terms of the general elements of effective teaching with which he should be familiar. Now we shall focus our gaze on the most important element in the teaching-learning situation, viz., the learner, and consider some of the kinds of insights regarding the learner as a whole person–as a complex and multi-faceted human organism –which it is important for the young teacher to develop. And in the final paper we shall investigate in even greater detail one particular aspect of the human organism–the learning process.

Education is the result of the dynamic interaction of the individual learner with his environment, with the total teaching-learning situation. If the teacher is to facilitate learning on the part of the student–to maximize learning–it would seem axiomatic that the teacher must understand the learner so he can establish the most appropriate learning environment. In order to work effectively with his students, the teacher must develop an awareness of the things which really count for them–their needs and wants, the things that bring them satisfaction, *their* learning objectives, etc. The teacher may not be wholly pleased with what he finds, but he has no recourse to face reality and accept the students as they are. He cannot pretend that his students are what he might like them to be. Regardless of the ultimate learning objectives, regardless of the intellectual paths along which he would like to lead the students, clearly he must begin with them where he finds them.

Necessary as it may be to work with students in groups and to plan learning experiences which will be optimum for an entire class, it is important for the developing young teacher to avoid thinking in terms of the *typical* student. There is no such thing, male or female, and a composite of all characteristics does an injustice to any single individual. It is true that we speak of "Betty Co-ed" and "Joe College," but in no sense are these meant to be "typical" individuals, other than as people enrolled in a given college or university. While it might be possible to speak in terms of such things as a mean age, mean levels of motivation, maturity, etc., mean level of intelligence, or mean parental income, the fact is that

Learning to teach and, in the larger sense, becoming an engineering educator, are processes about which we really know very little. They continually take place, they are very important, and they will soon become urgent. After much thoughtful study, the Committee on the Development of Engineering Faculties of ASEE organized the Cleveland Conference of 19–21 November, 1959, to bring together a small group who could identify and assemble the resources in our own and other fields, including formal education, that can best aid this process of learning to become a teacher and educator. This paper is one of the series originating from that Cleveland Conference.

the variations about these means are so great and the possible combinations so numerous that the teacher must retain an interest in the individual and his unique characteristics. Every class of students represents a multi-varied stage of advancement, both in the particular subject at hand as well as in all the other factors of intelligence, maturity, motivation, etc. Some 10% of our students are emotionally unstable but can be mentally brilliant; a few even have the rare quality of initiative.

The more we become concerned with the teaching-learning process, the more we become aware of the many different areas of experience which affect human beings as learners, of the different types of relevant factors in the background which the student brings with him to the teaching-learning situation. I should like to briefly discuss three of these factors—biological, psychological, and sociological.

Background Factors

The first of these factors, the biological or physical background given to the student through the geneology of his forebearers, is perhaps the most obvious and therefore requires the least discussion. However, this is not to suggest that they are of lesser importance to learning. Indeed, these biological factors can be of great importance because they not only shape what is to come in the native ability to learn through the sensory processes, but they also pre-determine the color of the skin, hair, and eyes, the texture of the hair, as well as the general skeletal structure of the individual. These latter can have a great influence on the personal development of the maturing individual, which personality in turn affects learning.

The second group of factors, the student's psychological background, is important because it is clear that in order to understand the student the teacher must not only make an effort to know the student's inherited capabilities but also his psychological makeup—his interests, the things that motivate him, etc. The extent to which a student learns with great facility and remembers most, or learns with great difficulty and forgets most, depends not only upon what kind of synapse centers he has inherited but also upon the manner in which he has learned to use them.

The psychological factors and mechanisms are the agents which elucidate and clarify the individual with his immediate environment in terms of understanding. At any particular time the learner must be able to ask himself: "How am I doing?", "What am I learning that I did not previously know?", "How am I relating to those around me?", or "What do others think of me?" Such questions are best answered by the individual evaluating his personal self in relation to everything outside, to both individuals and groups.

The psychological background will enable the individual to rate himself competitively with his peer group, because rank-order grouping will be made and placed where he can see how he ranks with others. His acceptance or rejection of these rankings can influence his learning climate and produce motivation factors to excel for his own sake, for the sake of outranking his peers, for the sake of pleasing his parents who may be financing his education, or for other reasons.

The learner's concepts of *self* and *self-other* play a large part in shaping ideas of confidence, status, self-evaluation, and esteem held by the individual toward himself and his immediate environment. If learning is to be enhanced, the things to be learned must somehow be woven into or related to the individual's present being or imagined being. Learning must start at a given point with anyone, and that point is usually where he is at present, not where an instructor would like him to be. This must be kept in mind at all times if the learner is not to be lost in the jargon and methodology of the formal educational process. Never at any time can we justify losing contact with the learner.

Therefore, one of the first items with which a young college teacher should be concerned is whether his discipline or subject matter is such that a student can be motivated by it and find it worthwhile for his effort. Too frequently instructors are interested primarily in teaching the subject, which is very close and impor-

tant to them, without giving concern as to how it may affect others. College courses must of necessity involve covering a certain amount and level of proficiency in order to provide a prerequisite for a more advanced subject in the same or related fields, but there is definitely the matter of the individual and his psychological background to be considered.

The third group of factors, the sociological background of the learner, has a very large influence on the behavior of the student, on his maturation process, and on his activity as a learner. The student comes to the classroom stamped with the imprints (and sometimes the scars) of the society of which he is a product. I am of the opinion that each student differs from every other one in many characteristics established by his prior environment. Students with an urban background differ from non-urban; those from wealthy homes differ from those reared in more frugal circumstances; those who are technically inclined differ markedly from those who are not. The mere passage of time brings new differences, for students differ from term to term, and from year to year, which is also true of the teachers.

There are differences arising out of varied religious backgrounds, differences resulting from geographical locale (past and present), differences due to amount and kind of work experience. There are differences due to sex, race, and national origin. Many students know what it means to be discriminated against, being a member of some kind of minority group —religious, racial, or national.

The home environment has a great impact on the student as a learner; many questions are relevant. Did the individual feel that he was loved and wanted in the home? Were there brothers and sisters in the home? Was there a sense of fairness exemplified in the behavior of the parents and all of the siblings? Were one or both of the parents authoritarian, or did the individual have some voice in family decisions? Did the parents get along together with a maximum of harmony and a minimum of friction in the home atmosphere?

Questions such as those listed above can have lasting influence upon the learner in shaping his attitudes and habit patterns. If the parents think well of the school and its staff, this can have a great influence upon the attitude of the learner toward himself and toward his parents or school. It is out of these conditions that motivation springs, and without motivation there is little real learning taking place, and if it does, it is frequently of little use in the individual's behavior. Learning for learning's sake has little place in our formal education today, or at least that is what we would like to believe. We say that learning should be meaningful if it is to be of value for the individual in living with himself or with others. Lundberg has said that man's social existence is just that, "learning the communicable techniques by which one may come to terms with himself and those around him." [1]

Thus we see that in approaching the learning situation of an individual we must be concerned with many, many things. What does the student expect to get from his college experience? On the other hand, what do we want him to learn and to achieve? What information is sought and what information is given? How does the student learn? In an attempt to know and understand the learner, in an attempt to gain an insight into what may motivate him to become an adequate individual in both the area of self satisfaction and social efficiency, we need to make every effort to know his abilities, his interests, his background, and his goals or ambitions.

To be truly effective the teacher must develop an appreciation of the many different areas of experience which influence the learner, a sensitivity to the complexity of the human organisms which face him from across the classroom table, and a humility in the face of the realization of the influence which the teacher can have, for good or ill, upon the further development and future life of his students.

[1] G. A. Lundberg, *Foundations of Sociology*, Macmillan Co., New York, 1939. P. 5.

Estimated Engineering Faculty Requirements 1959–60 to 1969–70

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1956–57 Survey of Projected Faculty Requirements

As the initial step in fulfilling its assignment, the ASEE Committee on Development of Engineering Faculties, with Harold L. Hazen, Dean of the Graduate School, Massachusetts Institute of Technology, as Chairman, undertook in the fall of 1956 to secure a firm estimate of engineering faculty requirements over the succeeding decade. This estimate was obtained by a survey of such requirements as expected by the deans of the country's engineering schools, conducted for the Committee by the Bureau of Business and Economic Research at Northeastern University in the spring of 1957.

On the basis of returns from 160 institutions representing 80% of the nation's total engineering enrollment, it was estimated that between 1956–57 and 1966–67, engineering enrollment would increase 70%, engineering faculties would increase 76%, and total faculty appointments, not including those of part-time assistants or of transfers from other engineering schools, to provide for this growth and replacements, would be 106% of the 1956–57 faculty strength. The full-time and full-time equivalent faculty strength estimated for all schools from the reporting sample was 9,078, of which 85% or 7,715 was composed of full-time faculty members. In addition the deans reported unfilled budgeted full-time positions, estimated for the country, as 732 in number or 8.1% of total faculty strength, and positions inadequately filled by part-time or temporary personnel totalling 532 or 5.9% of that strength.

The Committee on the Development of Engineering Faculties, knowing of Mr. Bridgman's interest in and work on the projections of engineering students and the consequent faculty needs, strongly urged him to make available to our profession the results of his most recent studies. CDEF believes that Mr. Bridgman's analysis deserves careful attention from every engineering education administrator.

1959–60 Follow-Up Survey and Comparisons of Findings

In the winter of 1959–60, the Committee determined that a follow-up survey of actual changes in faculty strength and of the number of appointments during the three-year interval would be of substantial value for comparing faculty and enrollment trends and calculating faculty replacement rates. This decision was influenced in part by the unexpected decline in freshman engineering enrollments in the fall of 1958 and of 1959, which reversed the substantial steady increase in them in each year since 1950.

The new survey, also conducted by the Bureau of Business and Economic Research at Northeastern, covered only institutions which had responded to the earlier survey and obtained responses from 116 of the 160 institutions in that group, representing 75% of their enrollment but only 60% of the total enrollment for the country. Although privately supported institutions were less well represented in this sample than were those publicly supported, enrollment trends within it were similar to those in all engineering schools and, in other respects, it appeared reasonably representative of all such schools. The following table shows the comparative enrollment trends.

TABLE 1

ENGINEERING ENROLLMENT TRENDS, FALL 1956 TO FALL 1959

	All Schools	CDEF 1960 Sample
Total	Plus 0.6%	Minus 2.9%
Undergraduate	Minus 3.4%	Minus 7.0%
Graduate	Plus 37.0%	Plus 44.4%
Junior, Senior and Graduate	Plus 13.6%	Plus 12.5%

To make certain of comparable data, all enrollment figures for schools were taken from reports of the U. S. Office of Education, "Engineering Enrollments and Degrees."

The final line of this table has been included as, in the Committee's judgment, the most significant enrollment figure for comparisons with engineering faculty trends. In all its work, the Committee has defined engineering faculty members as those persons who teach engineering or engineering science subjects to engineering students. It has excluded persons who teach engineering students other subjects such as basic science, mathematics or the humanities and social sciences. On this basis, a very high proportion of the engineering faculty teaching load involves only upper-class undergraduate and graduate students.

The next table summarizes the information on faculty strength secured from the 1956–57 survey and provides comparable data based on the 1959–60 survey. In both cases, these data represent national totals developed from the survey samples by M. A. Horowitz, Associate Director, of the Northeastern Bureau of Business and Economic Research.

The percentage increase for total full-time and equivalent faculty and for full-time members only is identical since in each year the proportion of full-time faculty was the same at 85%. Information on unfilled budgeted positions was confined, as requested, to full-time positions.

Although the actual increases in total and full-time faculty were 14.7%, part of this increase resulted from the filling of budgeted positions not filled in the earlier year, a non-recurring factor after the remaining similar positions are filled. The increase in budgeted positions, or the net increase in faculty strength, thus becomes 12.8% for the total faculty and 12.5% for its full-time members.

The numbers of full-time positions inadequately filled by temporary or part-time persons have not been given in the table or used in adjusting the rates of increase. As already stated, these were 532 in number or 5.9% of total faculty strength in 1956–57; their number had been reduced to 444 or 4.3% of that strength in 1959–60. It is believed that such a change is part of the normal replacement process and no adjustment for it would be proper.

The data provided in the 1959–60 survey concerning the number of full-time faculty appointments in the 3-year period since 1956–57, together with the figure on the increase in such faculty members, make it possible to determine the number of replacements which occurred and the annual replacement rate. Table 3 gives the figures invloved. The appointment figure does not include full-time men transferred from other engineering schools.

TABLE 2

ENGINEERING FACULTY STRENGTH ESTIMATED FOR ALL ENGINEERING SCHOOLS

	1956–57	1959–60	Percentage Increase
Total Full-time and Equivalent Faculty Strength	9,078	10,409	14.7%
Unfilled Budgeted Positions	732	656	—
All Budgeted Positions	9,810	11,065	12.8%
Full-time Faculty Members only	7,715	8,850	14.7%
Unfilled Budgeted Positions	732	656	—
Full-time Budgeted Positions	8,447	9,506	12.5%

TABLE 3

FULL-TIME FACULTY APPOINTMENTS AND REPLACEMENT RATES, 1956–57 TO 1959–60 ALL ENGINEERING SCHOOLS

Total Faculty Appointments	2,159
Increase in Faculty	1,135
Replacement of Faculty Members	1,024
Average Number on Faculty	8,282
3-Year Replacement Rate	12.4%
Annual Replacement Rate	4.1%

This rate reflects all losses, except transfers to other engineering schools, including both those due to retirement and death and those due to shifts to other types of employment. Other evidence indicates that, with the present age distribution of engineering faculties, the former losses are somewhat less than 2% annually. The remainder due to the latter causes, of 2–2.5%, appears to be substantially less than the rate of over 4% reported for them in the 1954–56 period by the ASEE Committee to Study Cross Migration between Faculty and Industry in the October 1956 JOURNAL OF ENGINEERING EDUCATION. Both of these are gross rates and the net rate of loss to industry reported by that committee was 1.6% annually. The gross rates, however, represent the replacement portion of the full-time faculty recruiting problem of both new holders of engineering degrees and men with appropriate experience in industry and government.

Significance of Findings for Faculty Projections

In summary, the surveys reviewed have shown that both total and full-time engineering faculties, exclusive of a reduction in unfilled positions, increased from 1956–57 to 1959–60 by 12.5% to 13.0% when junior through graduate enrollments, constituting a very high proportion of the teaching load of those faculties, increased in the sample used for estimating the faculty increase by 12.5%. In each of these two years, full-time faculty members constituted 85% of total full-time and full-time equivalent faculty strength. During these same years, the annual replacement rate in the full-time faculty was 4.1%.

From the former finding it will be assumed that in estimating faculty requirements from 1959–60 to 1969–70, the increase in faculty strength will be equal to the estimated increase in junior through graduate enrollments. The 4.1% replacement rate also will be used for this future period. It is recognized that changing conditions are likely to alter such projections to some undetermined extent. In particular, increased research activity by engineering faculties and relative increases in extended graduate work may demand more than such proportionate faculty increases which cannot be offset by improvements in teaching methods conserving faculty time. Nevertheless these assumptions appear to provide the most valid bases available for use in the projections.

Projection of Junior through Graduate Engineering Enrollments in 1969–70

To estimate the junior through graduate engineering enrollments 10 years hence requires a number of assumptions as follows:

1. Total first-time male fall enrollments in all collegiate curricula are assumed to increase from the 40% ratio of such enrollments to all 18 year old males occurring in 1959 by ½% annually to a ratio of 45% in 1969. The resulting enrollment figures have been smoothed to eliminate part of the computed sudden increase in 1965, due to the great increase in births in 1947, without changing the computed total numbers of such enrollments from 1964 to 1969. The trend in this ratio is that characteristic of recent years after adjustment for the effect of the varying military service flow on first-time male enrollments. Past enrollment figures were taken from the U. S. Office of Education reports on "Opening (Fall) Enrollments in Colleges and Universities" and past and projected numbers of 18 year old males were provided by the U. S. Bureau of the Census.

2. Engineering freshman enrollments for 1965–1967 are assumed to be 15.6% of total first-time male collegiate enrollments. This percentage is the average found for 1950 to 1959 inclusive. Its

TABLE 4

SELECTED PROJECTED DATA ON ENGINEERING ENROLLMENTS

Freshmen	
1965	115,000
1966	128,000
1967	129,000
3 year total	372,000
Junior through Graduate students	
1969 (61% of above total)	227,000
1959 (actual)	126,400
Increase 1959–69	80%

use eliminates such high ratios as the 17.8% which occurred in the fall of 1957 but anticipates recovery to the 1950–59 average from the low 1959 ratio of 13.8%.

3. Junior through graduate engineering enrollments in the fall of 1969 are assumed to be 61% of the sum of freshman enrollments in the falls of 1965, 1966 and 1967. This ratio is the average of junior through graduate enrollments to the sum of freshman enrollments 2, 3 and 4 years earlier which occurred in 1954–59 inclusive. Earlier years were not comparable because of the lower proportion of World War II veterans going on to graduate work. During 1954–59, this ratio varied from a high of 65% to a low of 55%, which occurred in 1959. Its rise assumes a recovery from that point.

The resulting figures for engineering enrollments for the pertinent years are shown in Table 4.

Projected Faculty Requirements 1959–60 to 1969–70

On the assumption stated previously that faculty increases would be estimated as equal to those in junior through graduate enrollments, the 80% increase in those enrollments from 1959 to 1969 would lead to an increase in total full-time and full-time equivalent faculty from 10,409 in 1959–60 to 18,737 in 1969–70. If, in addition, the 656 unfilled budgeted positions in the earlier year are filled, the total faculty would become 19,383 or 19,400 in round numbers. If the 85% ratio of full-time to total faculty found in 1956–57 and 1959–60 is assumed to continue, full-time faculty members would increase in number from 8850 to about 16,500.

Calculation of the estimated full-time replacements, using the 4.1% annual rate found for the 1956–57 to 1959–60 period, must take into account the fact that, due to recent high attrition rates and the decreases in freshman enrollments in 1958 and 1959, junior through graduate enrollments seem certain to decrease significantly next year and remain below the present level for an additional two years. Under the assumption of parallel movement of such enrollments and faculty strength, this would be expected to lead to a decline in that strength. Such a decrease, however, may be offset by the filling of presently vacant budgeted positions, while maintaining approximately the same total faculty. On this basis and assuming a straight line faculty growth from 1962–63 to 1969–70, the average strength of the full-time faculty for the ten year period becomes about 11,200 and the required replacements about 4,600.

The data developed in the preceding discussion are summarized in Table 5.

It is clear that the figure given for total full-time and full-time equivalent requirements does not include replacements of part-time faculty. These were designedly omitted from the 1956–57 CDEF survey and the precentage figure

TABLE 5

ENGINEERING FACULTY REQUIREMENTS, 1959–60 TO 1969–70

	Total Full-time and Full Time Equivalent	Full Time Only
Faculty 1959–60	10,410	8,850
Increase to 1969–70 (including filling of 656 vacant positions)	9,000	7,650
Percentage Increase	86%	86%
Replacements (full time only)	4,600	4,600
Total Requirements	13,600	12,250
Percentage of 1959–60	130%	140%

of 130% is given as the most closely comparable to that of 106% obtained in that survey for the 10 succeeding years. This difference arises largely from the higher percentage increase of the enrollment figures used, 80% for the junior through graduate enrollments as compared with the 70% in total enrollments in the first survey, and from a larger replacement rate, based on the actual 1956–57 to 1959–60 experience, 4.1% as compared with the rate of about 2.5% previously estimated.

Conclusion

Emphasis must be laid on the fact that these projected requirements are based on assumptions that the ratio of engineering freshmen to all first-time male collegiate students will return from the low point of 1959 to the average of 1950–1959 and that the retention rates of engineering students to the junior-graduate level also will return to the average of the most recent years which have been free from the influence of World War II veterans. If neither recovery should take place, the increase in junior-graduate enrollments by 1969 would be less than 50% rather than the 80% estimated and faculty requirements for both growth and replacement would be markedly smaller. Such a limited enrollment increase, however, would lead to only about 52,000 B.S. degrees in engineering in 1969–70 rather than the 62,000 estimated if recovery in relative freshman enrollments and in retention does occur. In either case, the effect of the recent declines in these two respects appears almost certain to hold the number of such degrees at or below the 1959 figure for 4 years. In view of the growth and increasingly technical complexity of our economy and the imperative demands of national defense, the lower figure appears likely to be completely inadequate for the nation's needs and the higher figure hardly adequate.

The mere possibility that freshman and upper-class engineering enrollments, in proportion to other college enrollments, might not recover from their present low points presents a special challenge to engineering education insofar as highly competent and understanding teaching is an important element in insuring such a recovery. The inevitably smaller upper-class and graduate enrollments of the next few years will provide an excellent opportunity to meet this challenge through improvements in the calibre and competence of existing faculties. These lower enrollments should not be permitted to divert attention from faculty problems and the necessity of preparing for the sharply increased requirements of the years immediately following.

In summary, careful consideration of the available data indicates that, despite the decreased engineering freshman enrollments in the fall of 1958 and of 1959, engineering faculty requirements for the ten years 1959–1969 are likely to be at least as great as those projected earlier for the ten years 1956–1966. Basic to this estimate is the assumption that the engineering schools will regain the proportion of all male freshman enrollments characteristic of the past decade and improve the low retention rates of the last four years. Very large increases in the eighteen-year-old age group will occur, particularly in 1965 and thereafter, and a higher proportion of that age group is almost certain to enter college. As a result of all these factors, upper-class and graduate enrollments will increase greatly and recent experience indicates that engineering faculties closely parallel their growth. Such an increase, plus the requirements for replacements, will lead to the need for recruiting, during the coming decade, new faculty members substantially exceeding in number the total present staff. The recruiting of such men and the development in them of the skills needed for teaching modern technology will demand unremitting attention. The accompanying problems of financial resources for adequate faculty salaries are tremendous.

A Competitive Project Design Course

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Competitive design teams working on a project have been used at North Carolina State College in teaching Aircraft Design for the past three years, during which time many techniques have been developed and tried. Although the development of these techniques is by no means complete, experience gained in handling groups or teams may prove helpful to others.

The purposes of teaching design in this manner are to achieve (1) a closer approach to the manner in which design is performed in industry, (2) a better method for inducing creativity, (3) a greater motivation of the student, and (4) ease in the handling of larger classes. The course, involving a one-hour lecture and two three-hour laboratory periods each week, is presented in the following manner. A letter which requests a preliminary design of a flight vehicle or system to perform a prescribed mission is presented to the class, which is divided into groups of 5 or 6 students. The results of the preliminary design are to be submitted at the end of the semester. Also a preliminary set of specifications and monthly progress reports are to be submitted by each group. Each team is allowed to use the laboratory time for their meetings to work on the project; the weekly lecture is given to the class as a whole. At the completion of the course, judges from industry are invited to the campus to hear each group's oral presentation of the design. Based upon this presentation and the written final report, a selection is made as to which group has (in the judges' opinion) produced the aircraft which most successfully fulfills the mission as described by the original letter. With this general outline of the course established, the techniques used in our attempt to accomplish the four purposes can now be discussed.

The Team

Each group must function well as a team. The instructor picks the original leaders, pointing out the need for compatability in the group and for a variety of talents. The group leaders select the additional members of the group. They are more successful in dividing the class equally and compatibly than the instructor. These initial leaders are chosen with considerable care. They should be above average in scholastic ability, but even more important, they should show leadership. Sometimes the officers of the local student societies make good initial group leaders. It was also found that the group leaders should be changed periodically, giving others within the group some chance to develop their leadership abilities. Each group was allowed to select subsequent leaders in any manner they chose. The first year that design was taught in this manner the group leaders were not changed and 50% of the students later said they thought the leaders should have been changed. The second year the group leaders were changed each month and 96% of the class favored this. (It should be noted that if the class opinion is widely split in a poll, then the procedure or technique was probably wrong.)

The Problem

The problem is stated in the form of a letter addressed to the instructor from a fictitious company asking for a preliminary design bid. Since these letters should be as realistic as possible, a great deal of care should be given to their preparation. Much of the motivation and creativity for the course comes with the problem. The letter must be clear in its meaning on all points covered. Any point not covered in the letter should be

left as a design decision for the groups to handle. The first year a detailed set of specifications for an airplane was given with the letter. This, it was found, did not lend creativity and so the procedure was changed. Now, each group has to make their own decision as to what type vehicle would solve the problem. As an example, one problem called for a cargo transport for operation in South America that could carry a 4,000-pound payload. No information was given about range, speed, or altitude. On their own, each group checked airport distances, mountain heights, etc., and drew up their own specifications. It is important to force the teams to decide on these specifications early. In order to keep any group from getting off to a completely wrong start, it is necessary that the group submit the specifications within the first two weeks for evaluation. One must be careful not to kill the creativity and motivation of a group when and if they do go wrong but rather to make them realize this approach was wrong through some key questions and general discussions and to gently guide them to another approach.

The Progress Report

The progress reports give the instructor a further check on the design approach of each group and give the students a chance to improve their report writing technique. In the comments on the report each group can be told officially the status of their design both as to progress and as to any technical errors—but carefully, without giving them the solution to the problem. The teams will learn the importance of a well written report when their mark on progress depends on how clearly it is described in the written report. Only one report is needed from each group. The design teams can jointly produce a better and more complete report in less time than each individual member of the class could do independently. Since the instructor has only 6 reports to grade, for a class of 30 students he can give each a more complete checking, and therefore more knowledge goes back to the students in the form of correction of errors.

The monthly progress reports are forwarded to the industrial judges, for their convenience in keeping pace with the development of the design. Thus, the judges become familiar with the design before the final report is submitted, and the students' motivation is improved because they want to have only their very best work seen by industry. The progress reports are seen only by the members of the group who wrote them. Because of the competitive nature of the design a certain amount of secrecy exists.

The Lecture Hour

A one-hour lecture is given to the entire class each week. In at least one of the early meetings some work in principles of creative thinking should be offered in order that the most effective use of creativity may be made during the developing of the specifications and early design. The lecture sessions are used to explain the basic problems connected with the design but no attempts should be made to solve the specific design called for in the letter. The topic for the lecture should follow the need for the knowledge by about one week. A delay longer than one week creates the danger of providing the basic information too late to do the student any good in his design decision. Delaying the information until the students have found the need for it will give greater emphasis to the lecture. It is convenient to bring in other members of the staff to discuss particular areas of interest to the class, such as power plants, mathematical operations, structures, etc. Frequent tests on the material covered in these lectures give a good guide as to how well the students are absorbing the information given during these sessions.

The Laboratory Period

Because of the competitive nature of the project, the groups will want to meet separately. Some teams may find that a few members or the whole group can use the laboratory time to best advantage by going to the library or making a trip to the airport, etc. No attendance record is kept. By visiting the meetings of the group which are in the building on any laboratory day, the instructor can observe the amount and quality of the participation of each student in the group.

During the course of a month the instructor will have several opportunities to observe each group in this manner.

The Marking System

In order to get an individual mark for the students, the instructor summarizes the information obtained during the laboratory session concerning the student's participation in the team's effort, using a merit review sheet similar to those used in industry. Under headings such as correctness of work, initiative, original contribution, cooperation with the group, etc., he rates each student much as an employer would rate his employees. This "employee mark" should be revised at frequent intervals throughout the course to allow the student to know what impression he is giving the instructor or "employer" and perhaps to make a better impression later; also it forces the instructor to observe the members of the class in a formal manner.

The procedure now used is to make up a sheet listing the qualities to be marked, with columns designated as excellent, very good, good, fair and poor. These evaluations can be readily assigned also with a letter or numerical grade, but it may be easier to think of the student's ability under these titles than in the terms of a number. The sheets are filled out by the instructor in the presence of only the student concerned, usually after the progress report is turned in. At the time they retire the student group leaders are asked to fill out these merit review sheets for each member of their groups. The opinions of the student leaders are most helpful in corroborating the opinion formed by the instructor. In some instances disagreement between the student leader and the instructor will arise as to the merits of some particular student. In such cases the final decision is of course that of the instructor, but it would be prudent on his part to make a more careful examination of the quality of the student in question during the next marking period. At first some of the students resented being asked to "grade" their fellow students or to be "graded" by them. If it is made clear that the final mark is that of the instructor and that the student leader's reports are only used to substantiate this mark as a check on possible injustices, they quickly accept this technique.

The student leader has some small amount of authority to accompany his responsibility in the group, and grading his teammates becomes a part of his training in leadership. This "employee mark" and the marks from the test given in the lecture make up the individual mark of each student.

Each team receives a monthly mark on the progress made by the group, a mark based on ability of the group to produce a well written progress report, and a mark based on how each group places in the competition. In marking progress, one must, to be fair, measure the progress of a group from where it was last month and not where they are on an absolute timetable; otherwise a group which starts slowly will never obtain a just final mark in this category, even with a superhuman effort.

These group marks are then used to modify the individual marks of each member of the team. With proper weighting of the group mark, an excellent student in the worst group should drop at the most one letter grade and a poor student in the best group should stand a chance of increasing his mark only one letter grade. This is a good compromise between maximum group incentive and individual reward.

The Judges

A word should be said, at this point, about the industries and the government agencies which have participated so generously in our program. The judges were all very well qualified and well prepared. They in no way commercialized the program. They took it upon themselves to visit the school during the year in order to see the class and better inform themselves. They had prepared pertinent questions on each design and left helpful commentary on both the designs and on the course. Many of the improvements in the presentation and techniques discussed here were tried at the suggestion of these men. On the poll, the students were asked whether any faculty members should be on the judging team and the answer has always been a negative one.

The Presentation

The presentation of the design to the judges provides an excellent chance for the students to gain experience in selling their technical ideas and an opportunity to practice speaking in public. Each group receives copies of the final reports of the other groups one week prior to the presentation, in order to permit them to evaluate the proposed design of the other groups. It is suggested that the presentation be in three parts: first, 15 or 20 minutes to let each group discuss the merits of their own design; second, 7 to 10 minutes to let each group discuss the failings of the other groups' design; and lastly, some small amount of time to let each group have a chance to explain or answer criticisms by other groups.

The first part is usually best handled if the students prepare a formal paper to present to the judges. One or more students may give this for each group. A hard rule about overtime will help to keep unfair advantage and hard feelings out of the competition. During the second part of the presentation the criticism should take the form of a commentary on the other groups' designs, rather than a direct question to a particular group which demands an immediate answer from the challenged group and hinders the progress of the program, disrupts the continuity of the speaker, and tends to promote bitterness between the groups. The third portion allows answers to the criticism and gives each group a chance to think out their answer, making them more logical and less personal. Questions by the judges were found to be stimulating to the students. The time for these questions was left at the end of each of the three parts of the program.

From the motivation standpoint, anything which adds to the formality of this presentation will increase the students' efforts: a proper setting, such as an auditorium; the presence of other members of the faculty; the presence of students from the junior class; printed programs, etc., are suggested as ways of making the program more formal.

The Critique

The critique should come during the week after the presentation. It should include a final discussion of the designs by the instructor. The critique should last for several hours so that the whole class can have time to express their views on the relative merit of the designs. During this session the students recognize the good points and failings of their own design and the relative merits of other groups' design. This is also a good time to straighten out any hard feelings that may have been brought on by the competition.

While the judges are trying to arrive at a decision they will make many comments about each design. If some listing of these is kept, without identification as to which judge made them, it will be found very useful. The students take the decision of the judges gracefully, but it is important for them to understand the decision and to have a chance to express their own views.

Summary

Since the decision three years ago to present the design course as a competitive project by groups rather than as an individual project, many changes in technique have been tried. The techniques given here are those which have been found to accomplish the purposes of the course best. Others were dropped because they did not achieve or in some cases they hindered the accomplishment of the purposes. It should be noted that a large number of the techniques are to motivate the student, that the student's opinion is always considered in the measuring of the acceptability of the technique, and that a policy of freedom of design is created for the student. If the instructor will add to this his confidence in the student's ability to produce a reasonable solution to even the most difficult parts of the design, compatible with the time they can give to the project, the design course will become a truly significant experience in engineering for the student.

The other techniques allow the instructor to determine the amount of achievement made by each student. With the use of these techniques supplemented by the judgment of the instructor, a fair and reasonable grade acceptable to both student and instructor is assumed.

What's Going On in ASEE

Engineering College Research Council

Annual Report for 1959–60

The Engineering College Research Council had another busy and productive year. Thanks are due especially to the chairmen of all committees, each of whom discharged his duties fully and faithfully, and to our secretary, Professor Contini, for his devoted service. The Executive Committee held two formal meetings since the last annual convention, on November 11 in St. Louis, Missouri, and on February 28 at the Illini Center in Chicago, Illinois.

Complete minutes of the activities of the Council are on file with the secretaries of both ECRC and ASEE. Among the important matters considered and actions taken are:

1. *New Members.* Admitted during the year were:
   George Washington University
   Howard University
   Newark College of Engineering

2. *Research Review.* The 1959 *Research Review* came off the press early in the fall with 118 institutions (5 more than in 1957) reporting substantially increased dollar volumes of research, together with more research projects and more personnel.

Material for the 1961 *Research Review* will be solicited starting October 1. Replies will be due by November 15, 1960.

The *Research Review* is now a joint project of the Secretary of ECRC and the Editor of the JOURNAL. This appears to be working well and should be so continued.

3. *Awards.* Donors for both the Bendix and McGraw awards have now approved nominal traveling expenses of $50 per member for the Nominating Committees.

The Curtis W. McGraw Award was made to Ali Bulent Cambel, Professor and Chairman, Mechanical Engineering Department, Northwestern University.

The Vincent Bendix Award was made to Maurice Joseph Zucrow, Professor of Gas Turbine and Jet Propulsion, Purdue University.

The plan of moving preliminary and documented nomination deadlines to January 1 and February 1 respectively with report to the Executive Committee for confirmation of nominations at the late February meeting worked well and should be continued.

4. *Committee on Relations with the Federal Government.* Recommended in November that immediate action be taken to make it possible for NIH to provide full overhead costs on research projects at universities. As a consequence, the General Council on November 12 voted to support the recommendation that ASEE express itself to ACE, presidents of member institutions of ASEE, the Assoc. of American Universities, etc. to the effect that necessary modifications in appropriation legislation be undertaken to permit NIH to accept the principles of Circular A-21 of the Bureau of the Budget and the overhead provisions contained therein.

Also recommended that the Business Officers Association accept responsibility for working out the difficult problem of rapid amortization of special research facilities in connection with Circular A-21.

The committee is continuing its studies of the grant procedures being adopted by the DOD and the possible changes in patent policy by the AEC.

5. *Committee on Research Administration.* Continued to act as catalyst in the area of Research in Engineering Education. A portion of the annual program this June is the result. Action, under President Teare, on the proposal for funding a comprehensive study program is still pending.

Recommended, and on April 16 had accepted by the Executive Committee of ASEE, the following resolution:

TEXT OF THE RECOMMENDATION OF THE ENGINEERING COLLEGE RESEARCH COUNCIL COMMITTEE ON RESEARCH ADMINISTRATION TO THE ECRC EXECUTIVE COMMITTEE as adopted February 27, 1960 (Approved by Executive Committee ASEE, April 16, 1960)

With the increasing volume of research in all areas of knowledge and the attendant increase in individuals and organizations in and associated with educational institutions responsible for the administration of such research, it has become increasingly necessary to have effective coordination between them in their efforts to establish effective policies and procedures to promote efficiency and support for such programs.

The ECRC Committee on Research Administration believes that the time has come to establish the means for such coordination. It therefore recommends that the American Society for Engineering Education approach the American Association of Land-Grant Colleges and State Universities and the National Federation of College and University Business Officers Associations and seek cosponsorship with ASEE in petitioning the American Council on Education for the establishment, under their agencies, of a coordinating council on research. It is recommended that the council be made up of representation from the offices of the petitioning organizations and other similar organizations having responsibility for research policies and the administration of research in, or affiliation with, educational institutions, as necessary to insure complete coverage of all disciplines.

It would be one of the important duties of such a coordinating council to provide the means for open forums on the problems basic to research administration, and the ASEE, Association of Land-Grant Colleges and State Universities, and the University Business Officers Associations offer to serve as hosts for such forums at their annual meetings. Such a coordinating council could also effectively represent the several organizations in negotiations with the agencies of the federal government in the areas relating to their sponsorship of research.

If sponsorship of this idea is accepted by the Association of Land-Grant Colleges and State Universities and the University Business Officers Associations, other appropriate organizations should be informed promptly of the proposal.

President Teare was to notify ACE of the proposal and that all deans of engineering and directors of research, as well as the Land-Grant Association and Association of Business Officers were to be informed of the action.

6. *Revisions of Qualifications for Membership in ECRC.* A proposed new procedure by means of which applications for institutional membership in ECRC will be judged has been developed and is being evaluated by five or six member institutions, using their present faculty teaching and research assignments as a basis for the study. It is hoped that a satisfactory revision of the qualifications will be ready for adoption at the annual meeting which will more effectively determine actual research activity than the present arbitrary dollar expenditure on research over a time limited period.

7. *Annual Meeting Program.* Under the able leadership of J. W. Hoffman an outstanding program was developed for the Purdue meeting.

8. *Nominations and Elections.* The report of the Nominating Committee was accepted and circulated in accordance with the constitution. All nominees were elected by a substantial majority as follows:

Chairman

R. J. Martin, University of Illinois

Vice-Chairman

C. C. Chambers, University of Pennsylvania (1 year)

J. C. Calhoun, Jr., A&M College of Texas (2 years)

Directors

M. A. Williamson, Pennsylvania State Univ. (1 year)

R. E. Burroughs, Univ. of Michigan (3 years)

J. W. Hoffman, Michigan State Univ. (3 years)

Our heartiest congratulations and best wishes are extended to each of the new officers.

I take this opportunity to thank Professor Contini, the committee chairmen, all members of the Executive Committee, Paul Bryant, Leighton Collins, and the many working members of the committees for their ready response to all requests and their sincere and effective efforts to forward the programs of the Council. Without their devoted service little could have been accomplished. It has been a privilege and a pleasure to serve the Society as chairman of the ECRC during the past two years.

Respectfully submitted,

KURT F. WENDT
Vice President ASEE for ECRC
June 13, 1960

Engineering College Administrative Council
Annual Report for 1959–60

The following brief report summarizes major activities of the ECAC and its committees during the past year.

1. *Executive Committee.* Two meetings of the Executive Committee have been held, one on June 18, 1959 at the University of Pittsburgh and one on November 11, 1959 in St. Louis, Missouri. The minutes of the first meeting were circulated in Bulletin XXIX and the minutes of the second meeting in Bulletin XXX.

2. *Ad Hoc Committee on the Role of ECAC and its Committees.* A committee of seven deans, who had served either as past officers or as members of the Executive Committee of ECAC, was asked at the beginning of the year to submit comments in answer to the question, "Is ECAC serving its primary constituents, in other words the heads of the engineering schools, as effectively as it should? Is the current committee pattern the best one?" Background information as to the responsibilities of the various committees was submitted with these questions.

There was unanimous belief that ECAC should limit its functions to matters primarily related to the area of the administration of engineering education. There was almost unanimous belief that the three current committees, one on Manpower, one on Military Affairs, and one on Secondary Schools should be continued as committees of ECAC. However, the majority believed that the current ECAC Committee on International Relations should be an ASEE committee instead.

The current ECAC Committee on Selection, Guidance and Placement came in for considerable discussion. No one had a clear-cut idea as to the role of this committee. Several expressed the viewpoint that it overlapped other committees and should be discontinued completely. Placement is a function which concerns the ASEE Relations With Industry Division, and also the ECAC Committee on Manpower. Selection of engineering students is a matter of interest to engineering deans and yet there is belief that this is a responsibility of the ECAC Committee on Secondary Schools. However, there did seem to be a consensus that the committee be retained as an ECAC Committee but that its title be changed to the Committee on Guidance.

There were three other committees which came in for considerable discussion. These are the ASEE Committee on National Legislation, the ASEE Committee on Relations with the National Science Foundation, and the ECRC Committee on Relations with the Federal Government. There was no unanimity of viewpoint concerning these three committees. The belief was expressed that all three were important committees, that all three were concerned with matters of deep interest to deans of engineering and to directors of research. One suggestion which merits further study is that these three committees be ASEE committees composed however of nominees submitted

by the ECAC and by the ECRC and that their reports be submitted jointly to the Executive Board of ASEE and to the heads of ECAC and ECRC.

There were two other suggestions. One was to the effect that ECAC be ready to appoint ad hoc committees whenever a particular problem arose which warranted such a committee and that ECAC should not rely too much upon a traditional pattern of standing committees. The second suggestion on which there was major agreement was that there should be three issues of the ECAC Bulletin each year, one early in the fall in September or October, one in January, and one in May.

3. *Committee on International Relations.* The Committee has worked closely throughout the year with the Committee on International Relations of EJC and it is believed that a mutually beneficial working relationship has been established.

The traditional ECAC Conference on International Relations was held on June 18, 1959, in connection with the ASEE Annual Meeting at Pittsburgh, Pennsylvania. The theme was, "Adapting American Education to the Needs of Technical Students from Rapidly Developing Countries." The total attendance at the conference, however, was only 44 in addition to the speakers.

The 1960 Annual Conference was held on June 22, at Purdue University. The theme was "The Role of ASEE in Latin American Relations."

To still further reflect the increasing interest and responsibility of the Society in international affairs, consideration has been requested for granting a General Session to an International Relations Conference at the Annual Meeting in 1961.

In response to a request from the Executive Board for recommendations as to action which ASEE should consider in the area of Latin America, the Committee is recommending, as a first step, the sponsoring of an ASEE mission to Latin America for the purpose of emphasizing the importance of engineering education to economic development of these countries and of recommending a suitable program of action for implementation by other appropriate organizations.

4. *Committee on Manpower.* The Committee planned a breakfast meeting at Purdue in order to discuss recent manpower developments. The chairman was also present at the ECAC meeting of Institutional Representatives and opened a discussion of the topic "Effect of Recent Enrollment Trends on the Supply of Engineers." Alarm has been expressed in some circles over the drop of undergraduate enrollment during the past two years and its effect on the available supply of engineers three and four years hence.

5. *Committee on Military Affairs.* The Committee has served primarily in a stand-by capacity during the past year. However, the chairman has kept informed on developments which are affecting the ROTC programs in the colleges. He attended the meeting of college administrators at Maxwell Air Force Base, Alabama, in December at which various ROTC problems were discussed. The Air Force has made a basic change in Air Force ROTC programs on campuses throughout the country, a change which will take effect at many institutions next fall. One-half of the Military Science subjects during the first two years of basic ROTC have been eliminated from the Air Force program and almost any academic subject counting towards an academic degree will be accepted in lieu thereof. However, Leadership Laboratory, in other words Drill, will still be retained for one hour per week through the first two years.

The Army ROTC in December 1959 was on the point of adopting a similar program but then changed its mind and now plans to retain the same number of military subject contact hours during the first two basic years. The result of most campuses where compulsory ROTC is in effect and where both Army and Air Force programs exist side by side will be that the great majority of freshmen next fall will elect Air Force ROTC rather than Army because they will have to devote less time to Military Science subjects.

Assistant Secretary of Defense Charles C. Finucane has given a directive to the Army and the Air Force ROTC Chiefs to come up with a plan involving the same number of contact hours. At the present

writing there is no indication that the Army and the Air Force have come to any agreement.

The Navy ROTC is not involved in this conflict between Army and Air. They are adhering to their four-year voluntary program, one-half of which approximately is subsidized.

6. *Committee on Secondary Schools.* All business has been transacted by correspondence this year. The Committee was asked by ECAC to review the "Recommendations for the Preparation of High School Teachers of Science and Mathematics—1959" as reported by the Sub-Committee on Teacher Certification of the American Association for the Advancement of Science. Those members of the Secondary Schools Committee who reported were in favor of approving the recommendations.

The major business transacted by the Secondary Schools Committee this year was to organize a joint conference for the 1960 Annual Meeting at Purdue University. The theme of the conference is "High School Preparation for College" with emphasis on prospective engineering students. The conference is a combined effort of the Divisions of English, Humanities, Physics, Mathematics, and the Secondary Schools Committee.

One objective of the conference is to bring together various divisions of ASEE who have mutual interests and problems. If a working relation between the divisions proves feasible and constructive, the Secondary Schools Committee may sponsor additional conferences on this nature.

A further objective of the conference is to improve the communications between high school faculties and engineering educators. The Secondary Schools Committee will consider ways and means of circulating the papers presented at the conference to high school faculties.

7. *Committee on Selection, Guidance and Placement.* The Committee's major activities during 1959–60 are as follows:

a. *Coordination* with the ASEE-ECAC Secondary Schools Committee and the ECPD National Guidance Committee has been made possible through membership of the chairmen of each of these committees on the ASEE-ECAC Selection, Guidance and Placement Committee and the willingness of the three chairmen to exchange information and plan joint efforts.

b. *Study of Dropouts.* A sub-committee, chaired by Mr. Donald Bridgman, began in 1958 a study of engineering student dropouts. This study led to the final report published as an article in the April 1960 JOURNAL OF ENGINEERING EDUCATION.

c. *The 1960 Annual Meeting Program* provides for (1) a joint luncheon meeting with the ECAC Secondary Schools Committee, (2) an afternoon session on Successful State Guidance Programs at which the ECPD National Guidance Committee chairman, several ECPD State Guidance Committee chairmen, and the chairman of the District of Columbia Joint Board on Science Education (in high schools) will speak, and (3) an afternoon session on placement and student personnel programs.

HAROLD L. WESSMAN
Chairman, ECAC
June, 1960

Report of the Vice President for General Divisions and Committees for 1959–60

The following general divisions and committees are responsible to this Vice President:

Ethics
Technical & Institute Curricula (ad hoc)
YET Committee
Cooperative Education
Educational Methods
Engineering Graphics
Engineering Economy
English
Evening Engineering Education
Graduate Studies
Humanities and Social Sciences
Mathematics
Physics

Relations with Industry
Technical Institute

The substance of reports which were submitted by chairmen or secretaries of the above groups is as follows:

Ethics Committee. The Ethics Committee is continuing to collect material looking forward to publishing a case book for those who are interested in teaching engineering ethics in college. In a survey of 155 colleges, 97 replied and 26 reported teaching engineering ethics as a separate class; 34 made some reference to ethics in other classes.

Alleged abuses in the hiring of engineering teachers by colleges have been brought to the attention of the committee and a code of procedure will be discussed at this annual meeting of the Society. Alleged abuses in the ethics of industrial recruiting have been brought to the attention of the committee and a revision is contemplated of the "Recruiting Practices and Procedures—1959" in order to take care of the problems more realistically.

Young Engineering Teachers Committee (CYET). Upon recommendation by the Executive Board of ASEE the YET Paper Contest was cancelled because of the lack of participation by young engineering teachers and the cost involved. Members of CYET were disappointed by the cancellation. In view of the time involved in arranging the Summer-in-Industry program and in view of the interest from young engineering teachers in summer employment the committee is recommending that the present program be abandoned and the CYET cooperate with the RWI Committee in the preparation and dissemination of the latter's extensive list of industries interested in hiring for the summer. This would eliminate duplication of effort but would still offer assistance to young engineering teachers who wished summer employment in industry. CYET and CDEF are co-sponsoring a conference of faculty development programs at the annual ASEE Meeting. In view of the cancellation of the Paper Contest the YET Newsletter was not published but it is recommended that two issues be published next year in order to reach all the young engineering teachers. It is felt by the committee that the YETitudes column in the JOURNAL OF ENGINEERING EDUCATION continues to be an excellent means of communication with members, but needs to be used more.

The YET Committee is concerned with the function which it should perform in view of the cancellation of the Paper Contest and the Summer-in-Industry Program. The Committee believes that the principal value of CYET lies in encouraging the formation of local ASEE groups which can be of great help to young engineering teachers and will reach more engineering teachers than will the Annual Meeting. The Committee recommends that the CYET be continued for at least one more year and be given permission to take appropriate steps to reactivate local ASEE Groups in cooperation with Institutional representatives and Deans. The Chairman and the Secretary have made excellent reports on their work.

Cooperative Education Division. The Cooperative Education Division reports a successful mid-winter meeting in Atlanta, Georgia, in February with some seventy-five persons in attendance. An endeavor is being made to bring industrial persons with a strong interest in education into membership of the Society; indications are that from 20 to 25 new members have come into the Society during the last year as a result of this activity. Members of the Division have cooperated in a recent study of cooperative education sponsored by the Thomas Alva Edison Foundation which was supported by a grant of $95,000.00 from the Fund for the Advancement of Education. This was not an official activity of the Division but was participated in by members since most persons involved are active members of the Division. A committee of the Division has finished a study of "Employer's Work Reports on Cooperative Students" and this was presented at the annual ASEE meeting in June.

Division of Engineering Graphics. The Division of Engineering Graphics has been one of the most alert groups of the Society for many years. Summer Schools are sponsored at approximately five-year

intervals and mid-winter meetings have been held for a long time. The Division sponsors the *Journal of Engineering Graphics*, which disseminates educational and technical information and news involving the interests of the members of the Division. In addition to these activities the Division has served as a cohesive force for the faculty members involved in engineering graphics for many years on a social as well as a professional basis.

English Division. The English Division has been active in encouraging and establishing English and Humanistic-Social Studies Divisional Meetings at regional ASEE meetings. Members of the Division have participated in the planning of joint sessions with other Divisions during the current annual meeting, particularly with Mathematics, Humanistic-Social Studies, and Secondary Schools Committees among others. Special emphasis is being placed on "Preparation of the High School Student for College Work." In cooperation with representatives from the National Council of Teachers of English, the College English Association, Modern Language Association, College Conference on Composition and Communication, and the Institute of Radio Engineers, the Division is endeavoring to establish a closer relationship between these organizations and to establish a joint committee to study further the field of English for engineering and technical students. The Division is also restudying the purpose of the English Division of ASEE and its relationship to other professional organizations in the area. This should lead to clarification of objectives and areas of activity of the Division.

Evening Engineering Education Division. The Evening Engineering Education Division is co-sponsoring meetings with other Divisions at the annual meeting of the Society and has not scheduled any separate conference of its own.

Graduate Studies Division. The Graduate Studies Division is likewise cooperating in general sessions at the Annual Meeting.

Division of Humanities and Social Sciences. The Division of Humanities and Social Sciences conducted jointly with the English Division a summer school in 1959 that was held for two days immediately following the annual meeting in Pittsburgh. The Division produces and distributes periodically its News Letter, and members of the Division have published four papers in the April edition of the JOURNAL OF ENGINEERING EDUCATION.

Physics Division. The Physics Division has cooperated with other Divisions of the Society in increasing the number of joint meetings and decreasing the number of purely Divisional activities at the annual meeting. Since this is some departure from past practice its value cannot be assessed until after the Purdue Meeting.

Relations with Industry Division. The Relations with Industry Division has been particularly active during the last year. Two meetings of the Steering Committee and two meetings of the Board of Directors were held during the last year to review the present status of activities and to discuss and plan future work. A successful College-Industry conference co-sponsored with Washington University was held in January 1960 and a like conference for 1961 will be co-sponsored with the University of Cincinnati. The Division continues to publish in the JOURNAL opportunities for planned conferences and summer work for faculty. Increased activity in local sections has been improved to the extent that each ASEE section now has an RWI liaison representative. A project committee has been established in order to review and screen suggestions for short- and long-range activity of the Division.

Technical Institute Division. The Technical Institute Division has been especially active during the past year. Members are working with the English-Speaking Union in a teacher exchange between Technical Institute faculty in Great Britain and in the United States. The Division was instrumental in securing National Science Foundation support for sponsorship of two institutes for Technical Institute faculty during the summer of 1960. These will be of eight weeks' duration and held at the University of Houston and at Oklahoma State University respectively. The Division is cooperating with other divisions in holding

joint sessions at the time of the Annual Meeting. A special committee has been appointed to study the possible reorganization of the Division so the Division will better accomplish its aims and its objectives. The Division is working with the Directors of some 84 guidance institutes being conducted through funds allocated in the National Defense Education Act. Appropriate materials about Technical Institute education are being provided the Institute Directors for distribution to those attending these institutes. The Relations with Industry Committee of the Technical Institute Division is promoting a number of industrially sponsored guidance clinics for public school guidance personnel. About 15 of these have been held so far this year and have been well received. Assistance is being rendered the American Association of Collegiate Registrars and Admissions Officers in rewriting their "Glossary of Terms" relating to technicians and technical institute education. The Division is considering the development of a fifteen-minute motion picture film to be used as a recruiting device for technical institute students. The Division is proposing a study of "Evaluation of Technical Institute Education" to be sponsored by one of the national foundations. This study is intended to provide a look ahead at technical education and to provide a basis for accreditation of curricula similar to that which the "Evaluation of Engineering Education" did for the baccalaureate degree programs in engineering.

Miscellaneous. From the above it can be seen that many of the general divisions and committees in this group are aware of the changing patterns in engineering education and are constantly striving to adjust their aims, objectives and approaches to the solutions of these problems. All of this poses a problem involving communications between these committees, divisions and the executive board of the Society. The Vice President to whom they report is endeavoring to improve these communications and to encourage and establish such organizational ties as are needed for more effective contribution to the work of the Society and its constituent parts. It is the work of committees and divisions of this kind that will determine much of the progress that engineering education will make in the next few years.

Your Vice President attended all of the meetings of the Executive Board and the General Council of the Society. He has been assigned the responsibility of liaison between the Executive Board and Technical Institute Division of the Society in connection with the proposed study, "Evaluation of Technical Institute Education." He has served as chairman of an executive board special study committee on "Cost of the Society to Members and Institutions." He has proposed to the divisions and committees in his group that thought be given to ways in which they and he can serve more effectively their individual members as well as the Society as a unit.

H. W. BARLOW
Vice President for General Divisions and Committees
June 15, 1960

Report of the Vice President for Instructional Divisions 1959–60

For the past two years the Instructional Divisions of the Society have been endeavoring to attain a more cohesive organization within the Society and also to develop stronger ties with related groups outside our membership. Both phases of this program showed progress during 1959–60.

Examples of steps taken to attain more internal cohesion are evident in the program for the 68th Annual Meeting. One General Session sponsored jointly by the Divisions of Aeronautical Engineering, Mathematics, and Physics brought to the entire membership information on the significance for engineering education of new developments in these three fields. The Mineral Engineering Division in cooperation with the Metallurgical and Ceramic Engineering Committees pre-

sented a two-part program on the engineering science of materials in undergraduate engineering curricula. The Electrical Engineering Division, the Relations with Industry Division and the IRE Professional Group on Education cooperated in the presentation of three programs devoted to solid state electronics. The General Council in cooperation with eight Divisions sponsored a conference which featured reports from the Education Committees of eight of the related professional societies.

In addition to the activities at the Annual Meeting, many other steps were taken during the year to improve communications among the professional societies and ASEE. For example, the Electrical Engineering Division and two professional groups of the IRE produced the Northeastern Electronic Research and Engineering Meeting in November 1959. The Industrial Engineering Division and the American Society of Tool and Manufacturing Engineers jointly sponsored a summer school on metal processing. Several of the Divisions of ASEE are arranging for an overlapping of membership on the education committees of related professional societies. The Divisions are also continuing their efforts to enroll more of the leading practicing engineers as members of ASEE.

Pending a report by the Policy Committee which was assigned the task of studying the structure of the ASEE, it is proposed that the Instructional Divisions continue the present program of integration within the Society and improved liaison with outside groups.

Submitted by,

ELMER C. EASTON
Vice President for Instructional Divisions
June 1960

Report of the Vice President for Western Sections—1959–60

1. Introduction. The general excellence of the annual meetings of Western Sections of the American Society for Engineering Education during the academic year 1959–60 may well be attributed to superior programs and a genuine interest in the problems of engineering education.

2. Meetings and Attendance. The Western Region of ASEE consists of seven sections. Each of these sections held one regular meeting during the year. In addition, the Pacific Southwest Section held two regional meetings—one at Harvey Mudd College and the other at San Jose State College.

The Missouri-Arkansas and Rocky Mountain Sections both scheduled one-day meetings on a Saturday, but both scheduled a preliminary informal get-together on the preceding Friday evening. The Pacific Southwest Section meeting was two days long, and the North Midwest Section meeting which extended over two days was preceded by a measurement workshop of one day's duration, which was sponsored by the Committee for Young Engineering Teachers of the North Midwest Section. The other sections generally conformed to a standard pattern of day-and-a-half meetings. The reported attendance at all meetings was 1118 members and guests.

Vice President Kurt F. Wendt attended the North Midwest Section meetings at Iowa State University of Science and Technology, Ames, Iowa, October 16–17, 1959. Because of illness, Vice President C. L. Eckel was unable to attend the fortieth annual meeting of the Kansas-Nebraska Section which was held at the University of Kansas, Lawrence, Kansas, October 23–24, 1959. Vice President H. E. Wessman attended the Pacific Southwest Section meeting which was held at Los Angeles State College on December 28–29, 1959. Unfortunately, no officer of the Society was available for the meeting of the Missouri-Arkansas Section which was held at the University of Missouri, Columbia, Missouri, April 23, 1960; and it was impossible for any officer of the Society to attend the thirty-fourth annual meeting of the Southwest Section which was held at Lamar State College of Technology, Beaumont, Texas, April 29–30, 1960. Secretary W. Leighton

Collins and Vice President C. L. Eckel attended the Rocky Mountain Section annual meeting which was held at the United States Air Force Academy, near Colorado Springs, Colorado, April 29–30, 1960. Secretary Collins attended this meeting primarily for the purpose of making an estimate of the situation which will obtain in June 1692, when the annual meeting of the Society will be held at the United States Air Force Academy. Vice President Howard W. Barlow attended the annual meeting of the Pacific Northwest Section which was held at the University of Idaho, Moscow, Idaho, May 13–14, 1960.

3. *Finance.* Three sections reported no dues or registration fees. Three sections reported registration fees—two of one dollar each and one of two dollars. One section reported dues of one dollar with a note that these will be raised to two dollars next year. Presumably, the major expenses of section meetings are financed through local assessments or by the host institutions.

4. *Topics.* Each section planned its program independently of the other sections. Aside from a business session and a banquet, usually with a speaker who discussed a topic of general interest, there was a wide diversity in programs. Only one section (Rocky Mountain) reported a general theme for its meeting. This was "Teacher Preparation."

In general, a section program was built around a core of technical discussions, round table discussions, panels, or multi-topic discussions dealing with important aspects of engineering education. A few of the topics discussed at general meetings include "Humanities and Social Sciences Program," "Engineering Sciences in the Undergraduate Curriculum," "It's the Teacher and Not the Text," "Schizophrenia in Engineering," "A Study of Certain Incentives of Attracting and Retaining Teachers," and "Educational Philosophy and Motivation." Several sections scheduled a deans' meeting for discussion of problems of mutual interest.

5. *Young Engineering Teachers.* The Committee for Young Engineering Teachers sponsored a one-day Measurement Workshop preceding the North Midwest Section meeting. The Kansas-Nebraska Section reported a YET breakfast meeting which permitted discussion of YET activities in the Section. The Pacific Southwest Section scheduled a session for the presentation of Young Engineering Teachers' prize papers and the presentation of section prizes. Some YET activity was noted in the Southwest Section. Nothing else of note was reported. Thus it seems that major YET participation was in the North Midwest Section and in the Pacific Southwest Section. Generally speaking, Young Engineering Teachers were reported to have participated in membership drives.

Because only one section (Pacific Southwest) reported a YET Paper Contest, I have again reluctantly come to the conclusion that the young engineering teachers who should be interested in the YET Paper Contest are devoting their efforts to research, publication of technical papers, and other aspects of professional development which weigh heavily when promotion and salary increases are involved. I think that this program is of doubtful value and believe that the younger members of the Society might well be integrated with the older members of the Society.

6. *Branches.* No section made a specific report concerning any activities of its branches. It seems, however, that some institutional branches operate in an informal manner, and undoubtedly the influence of the branches has served to stimulate participation in activities of the sections and in conducting membership drives.

7. *Conclusion.* To keep all sections in the Western region informed about what is going on, I have attempted to arrange for an exchange of section programs. This exchange of programs should be continued. In planning programs for the coming year, I think that the Report of the Committee on the Development of Engineering Faculties should be used as a guide to create an interest in teaching as a profession. There should also be a continuing interest on the Report of the Follow-Up Committee on the Evaluation of Engineering Education. Encouragement should be given to the participation of technical institute personnel in sections' programs, and discussion relat-

ing to technical institute education will no doubt prove valuable. Every effort should be made to pay attention to technical institute activities and to obtain participation or representation from industry in section activities.

In conclusion, I want to express appreciation to the officers of the Western Sections for their cooperation during the past three years. It has been a great privilege and honor to serve as Vice President for Western Sections during the years 1957–60.

Respectfully submitted,

C. L. ECKEL
Vice President, ASEE
June, 1960

Report of Vice President for Eastern Sections—1959–60

Introduction. From information available at this writing, it appears that this has been an active year for the nine Sections which comprise the group representing the East Sections of ASEE. Many excellent programs were prepared and presented. At the time of the preparation of this report not all of the Sections had submitted their annual reports to Secretary Collins, a copy of which was to have been forwarded to the Vice President in charge of East Sections. This report will cover the activities of those sections for which information is available to the Vice President at this time. It was not possible for the Vice President to attend all of the East Section annual meetings. However, he did have the pleasure of attending the meeting of the Southeastern Section at Columbia, South Carolina, and the meeting of the Ohio Section in Cleveland, Ohio, where Fenn College was the host institution. In addition the meeting of the Co-op Division was attended at Georgia Institute of Technology.

An outline giving pertinent information, such as attendance, dues, registration fees, etc., on the principal annual meetings of the East Sections is included in this report.

Meetings. A check of last year's report, submitted by Vice President Van Houten, indicates that the number and duration of the East Section meetings last year were essentially the same as this year. The Illinois-Indiana Section held a one-day meeting on May 14 at Rose Polytechnic Institute. The Middle Atlantic Section held two one-day meetings. The first was a fall meeting, held at Pratt Institute on December 5, 1959, the second was a spring meeting, held at E. I. du Pont de Nemours & Co., in Wilmington, Delaware, on May 14, 1960. The Middle Atlantic Section held three meetings during the year. The New England Section met at the University of Connecticut on October 16–17, 1959. The Ohio Section held a one-day meeting at Fenn College, using the evening preceding the meeting for a tour of the Fisher Body Plant in Cleveland. The Southeastern Section held a two-day meeting in Columbia, South Carolina, with the University of South Carolina as host. Registration was held, together with a tea, on the evening preceding the two-day meeting. A two-day meeting was held by the Upper New York-Ontario Section on October 23–24, 1959. It will be noticed that seven of the nine sections scheduled their principal meeting in April or May, while the other two sections held their meetings in the fall.

Financing. The greater number of the Sections had a registration fee for their meetings, which ranged from 50 cents to $4. These Sections had no Section dues. The New England Section financed its activities by a $20 dues fee paid by each institutional member of the Section. One other Section, the National Capital Area, charged each member $1 dues. No registration fee was charged.

Topics. Topics such as the curriculum, research and the recruitment and development of engineering faculties were considered by a number of the Sections. The method of treatment of these subjects ranged from formal addresses

to panel discussions with audience participation. Creativity was the theme of the Middle Atlantic Section's fall meeting at Pratt Institute. Some attention was given to Professional Engineering and Registration by the New England Section.

Branches. Officially, at the present time, there are eleven Branches of the Society in the East Sections region. An effort is presently being made to establish additional Branches and to encourage those Branches now in existence. Letters have been written to 81 deans of engineering, or other appropriate administrative officers, in the East Sections region on campuses where Branches are not in existence, requesting them to consider the establishing of Branches of the Society on their campuses. The results of this letter campaign for the establishing of Branches are not complete at this writing. A full report on this project will be made later.

General Observations. Although one year is a short time to evaluate the relative effectiveness of the various Sections in the work of the Society, and to familiarize one's self with all of the activities of the Sections, certain observations may be made.

A general impression was obtained that some of the Sections are doing an excellent job. In this respect the Southeastern Section must be mentioned as one which had an excellent two-day meeting during the past year. It is interesting to note that the Section administratively is organized into three divisions: Administrative, Instructional and Research. Each division has a chairman, vice chairman and secretary. It is noted that some of the Sections had very little participation by industry in their meetings, while others had a great amount. The spring meeting of the Middle Atlantic Section held at E. I. du Pont de Nemours & Co., is an example of a very fine meeting of cooperation with industry at its best. Perhaps this type of meeting should be given more encouragement in the future than it has had in the past. One final observation is that communications between the Section officers and the National officers of the Society should be improved. Perhaps with the proper effort we will be able to improve this considerably. All of us should make a special effort along this line during the coming year.

I have enjoyed my work with the Sections during the past year and I am looking forward to a very enjoyable and profitable year for all of us.

Respectfully submitted,

RALPH G. OWENS
Vice President, East Sections
June 10, 1960

SYMPOSIUM ON LARGE CAPACITY MEMORY TECHNIQUES FOR COMPUTING SYSTEMS

A Symposium on Large Capacity Memory Techniques for Computing Systems will be held on *May 23, 24 and 25, 1961,* sponsored by the Information Systems Branch, Office of Naval Research. The Symposium will be held in the *Department of Interior Auditorium* on C Street, between 18th and 19th Streets, N.W., Washington, D. C.

Attendance is open to all interested technical personnel. Individuals may receive further information and a preliminary Symposium program, when available, by contacting: Miss Josephine Leno, Code 430A, Office of Naval Research, Washington 25, D. C.

Colleges and University Short Courses and Conferences, 1960–1961

Following is a list of short courses and conferences of interest to engineering educators and open to them. This information was compiled by the JOURNAL staff. Plans are now being made for a listing in an early spring issue of such short courses and conferences which are to take place during the summer of 1961. Information concerning any such courses or conferences not already in the present list should be sent to the Editor, JOURNAL OF ENGINEERING EDUCATION, University of Illinois, Urbana, Ill. The material should be sent in immediately if it is to be available before our printing deadline.

Aero-Space Engineering Seminars

Date: Bi-monthly
Objective: Technical and scientific discussion
For: Grad. students, faculty, invited guests from industry
Limitations: Area
Address: Dept. of Aero. Eng'g, University of Cincinnati

Aerospace Manufacturing Technology—ASTME Seminar

Date: April 14–15, 1961
Objective: To present properties of ultra-high-strength materials for latest techniques for their fabrication into aerospace products
For: Engineering level type of group, both students and industry
Limitations: Regionally sponsored, national attendance
Fee: Members ASTME–$10.00. Nonmembers–$15.00 ($5.00 of this may be applied to initiation fee if one decides to become a member)
Address: For additional information: Prof. B. S. Mesick, Mechanical Engineering Department, College of Engineering, The University of Arizona, Tucson, Arizona

Basic Engineering, Institute on

Date: June 14–July 25, 1961
Objective: To up-grade teachers of basic engineering courses in graphics, statistics and engineering problems
For: College and junior college teachers
Limitations: National, total number, 50
Fee: National Science Foundation pays each participant $450.00 plus travel allowance plus dependent allowance
Address: Prof. L. R. Hillyard, 106 Marston Hall, Iowa State University, Ames, Ia. Proposal has been submitted to the National Science Foundation for the support of this Institute

Basic Engineering Refresher

Date: November 11–12, 1960
Objective: Preparation for EIT portion of state examination
For: To assist prospective Professional Engineers
Fee: Waived for full time academic staff working in academic field
Address: Engineering Institutes, University Extension, University of Wisconsin, Madison, Wisconsin

Bio-Oxidation of Organic Wastes—Theory and Design

Date: June 1961—annually
Objective: Biological treatment design procedures for educators, engineers and industrialists
Limitations: Maximum 35 registrants
Fee: $125
Address: Civil Engineering Department, Manhattan College, New York 71, N. Y.

Chemical and Metallurgical Engineering Refresher

Date: March 17–18, 1961
Objective: Preparation for chemical & metallurgical specialty exam
For: Prospective professional engineers specializing in chem. & metal. engineering
Fee: Waived for full time academic staff working in academic field
Address: Engineering Institutes, University Extension, University of Wisconsin, Madison, Wisconsin

Chemical Engineering Conference on Distillation Calculations

Date: November 8–9, 1960
Objective: Review principles of distillation calculation methods and discuss techniques of adapting them to digital com-

puters. New theoretical and empirical developments will also be presented
For: Chemical and process engineers
Fee: $50.00
Address: L. F. Sheerar, Engr. & Ind. Ext., Okla. State Univ., Stillwater, Okla.

Chemical Engineering Conference on Molecular Physics

Date: October 4–5, 1960
Objective: Present lectures by Prof. Dr. A. M. F. Michels to an audience of top level engineers and scientists from academic and industrial institutions
Fee: $50.00
Address: L. F. Sheerar, Engr. & Ind. Ext., Okla. State Univ., Stillwater, Okla.

Civil Engineering Refresher

Date: January 27–28, 1961
Objective: Preparation for Civil Engineering specialty examination
For: Prospective professional engineers specializing in civil engineering
Fee: Waived for full time academic staff working in academic field
Address: Engineering Institutes, University Extension, University of Wisconsin, Madison, Wisconsin

Computers and Data Processing, 8th Annual Symposium on

Date: End of June or July–2 days
Objective: Discuss newest designs
For: Engineers–research and development
Fee: $25.00 per person
Address: Wm. H. Eichelberger, Electronics Division, Denver Research Institute, University of Denver, Denver 10, Colorado

Concrete Conference

Date: Annual event–December 13–14, 1960
Objective: For technical discussions of latest developments in concrete methods
For: Engineers, contractors, and sales representatives
Limitations: Southeastern regional conference
Fee: $5.00
Address: College Extension Division, P.O. Box 5125, State College Station, Raleigh, North Carolina

Digital Computers, Applications of, to Solution of Engineering Problems

Date: February 8–June 6, 1961
Objective: Explore the techniques used to prepare problems for solution
For: Engineers and technical personnel
Fee: $50.00
Address: Special Courses Division, Newark College of Engineering, Newark 2, N. J.

Electrical Engineering Refresher

Date: May 26–27, 1961
Objective: Preparation for electrical engineering specialty exam
For: Prospective professional engineers specializing in electrical engineering
Fee: Waived for full time academic staff working in academic field
Address: Engineering Institutes, University Extension, University of Wisconsin, Madison, Wisconsin

Electrical Equipment for the Textile Industry

Date: November 10–11, 1960
Objective: For discussions of technical problems common to the textile industry and the electrical engineering field
For: Electrical engineers and textile industrialists
Fee: $15.00
Address: College Extension Division, P.O. Box 5125, State College Station, Raleigh, North Carolina

Engineering Science for College Teachers of Engineering, Summer Institute in

Date: (6 weeks) July 10th through August 18th
Objective: Enable college teachers of engineering to deepen their backgrounds in the fields of thermodynamics, structure of matter, transport phenomena and methods of matrix-tensor analysis
For: To develop a greater understanding and appreciation for the fundamental unity of the various engineering sciences
Fee: Sponsored by the National Science Foundation
Address: Professor Robert H. Seavy, Director, Stevens Institute of Technology, Hoboken, New Jersey

Engineering Teachers, Institute to Improve Professional Competence of

Date: July 1–August 31, 1961
Objective: To up-grade engineering teachers in the fields of processing of energy, processing of information and nature of materials
For: College and university teachers of engineering
Limitations: National, maximum number, 50
Fee: Ford Foundation would pay each participant $1,400 plus travel allowance
Address: Dr. Glenn Murphy, 213 Marston Hall, Iowa State University, Ames, Iowa. We have just begun discussions with

the Ford Foundation for the sponsorship of this program

Fluid and Solid Mechanics, Midwest Conference on

Date: September 6–8, 1961
Objective: Further the advancement of fluid and solid mechanics
For: Scientists, engineers and teachers
Fee: $15.00
Address: Continuing Education Service, Kellogg Center, Michigan State University, East Lansing, Michigan

Gas Chromatography, International Symposium on

Date: June 14–16, 1961
Objective: To better acquaint engineers, scientists and college faculty with new techniques and theories in relation to the various gases
For: Engineers, scientists, and college faculty
Address: Continuing Education Service, Kellogg Center, Michigan State University, East Lansing, Michigan

Government Contract Negotiation and Administration, Short Course on

Date: January 16–27, 1961
Objective: Latest techniques in negotiation and administration
For: Those who deal with defense contracts
Fee: $200.00
Address: Sam Houston, Engineering Extension, University of California, Los Angeles, California

Heat Transfer Conference, International

Date: August 27–Sept. 1, 1961
For: Mechanical and chemical engineers
Fee: $30.00
Address: Prof. Benjamin Spurlock, Mech. Engineering Dept., University of Colo., Boulder, Colorado

Heat Transfer Symposium

Date: March 6, 7, 1961
Objective: Theory and fundamentals of heat transfer and application to specific problems
For: Mechanical engineers
Fee: $10.00
Address: Prof. Erich A. Farber, College of Engineering, University of Florida, Gainesville, Florida

JETS Leadership Conference

Date: Fall, 1961
Objective: To improve high school organization in engineering
For: High school students, faculty advisors, industrial representatives
Address: Continuing Education Service, Kellogg Center, Michigan State University, East Lansing, Michigan

Magnetodynamics, Engineering Applications of

Date: October 27–28, 1960
Objective: Present overview of various phases of engineering-linked applications in magnetodynamics
For: Industrial research scientists and engineers and engineering and science teachers
Limitations: None
Fee: Waived for full time academic staff working in academic field
Address: Engineering Institutes, University Extension, University of Wisconsin, Madison, Wisconsin

Materials, Summer Institute on Properties of

Date: July 13–August 23, 1961
Objective: Classroom and laboratory work in modern science of engineering materials
For: College and university teachers of engineering
Limitations: National. Total number, 50
Fee: National Science Foundation pays each participant $450.00 plus travel allowances plus dependent allowances
Address: Dr. Glenn Murphy, 213 Marston Hall, Iowa State University, Ames, Iowa. Proposal for this Institute has been submitted to National Science Foundation

Mechanical Engineering Refresher

Date: April 21–22, 1961
Objective: Preparation for mechanical engineering specialty exam
For: Prospective professional engineers specializing in mechanical engineering
Fee: Waived for full time academic staff working in academic field
Address: Engineering Institutes, University Extension, University of Wisconsin, Madison, Wisconsin

Operations Research and Systems Engineering

Date: June 5–16, 1961 (Probable)
Objective: Introductory training
For: Executives, government, military, academic personnel
Fee: $300
Address: Mr. John P. Young, Johns Hopkins Univ., Baltimore 18, Md.

Photointerpretation and Photogrammetry, Short course in

Date: January 23 to February 3, 1961
Objective: Instruction in the uses of aerial photography
For: Practicing engineers and scientists who have little previous training
Limitations: At least a bachelor's degree in a scientific or engineering area
Fee: $200 plus living expenses
Address: Hollister Hall, Cornell University, Ithaca, New York

Plasma Dynamics, Advanced Technology Seminar on

Date: January 9, 10, 1961
For: Anyone interested in plasma dynamics
Fee: $32.00
Address: Dr. J. P. Holman, School of Engineering, S.M.U., Dallas 22, Texas

Polymer Technology, Applied

Date: September 27, 1960 to January 31, 1961—annually
Objective: Condensation polymers and applications—followed by Spring Seminar
For: Chemical engineering and chemistry graduates
Fee: $55.00
Address: Special Courses Division, Newark College of Engineering, Newark 2, N. J.

Protective Relay Engineers, Conference for

Date: April 17–19, 1961
Objective: Power system protection, transmission and allied problems
For: Utility engineers, educators and consultants
Fee: Registration fee—$10.00
Address: L. M. Haupt, Conference Chairman, Department of Electrical Eng., Texas A. and M. College, College Station, Texas

Roads & Streets Conference, Arizona

Date: November, 1961
Objective: Papers related to highway, traffic and transportation engineering
For: Engineers, highway officials, engineering educators
Fee: $3.00
Address: Arizona Transportation & Traffic Institute, University of Arizona

Safety Engineering Conference

Date: November 7–8, 1960
Objective: To present latest information on safety, industrial catastrophes, accidents and preventive measures
For: Safety engineers, personnel departments, plant engineers, supervisors and managers
Limitations: 40 enrollees
Fee: $40.00
Address: L. F. Sheerar, Engr. & Ind. Ext., Okla. State Univ., Stillwater, Okla.

Solar Energy Symposium

Date: April 3, 4, 1961
Objective: Current developments in the field of solar energy and its applications
For: Engineers and building construction personnel
Fee: $10.00
Address: Prof. Erich A. Farber, College of Engineering, University of Florida, Gainesville, Florida

Solid-State Circuits Conference, 1961 International

Date: February 15–17, 1961—annual
For: Graduate engineers
Fee: $8.00
Address: H. G. Sparks, University of Penna., Moore School, 200 S. 33rd St., Philadelphia, Pa.

Spectroscopy, Southeastern Seminar on

Date: January 4, 5, 6, 1961
Objective: To augment knowledge of the basic physical nature of spectra
For: Personnel engaged in basic and applied spectrochemical procedures
Fee: $15.00
Address: Professor Wm. T. Tiffin, College of Engineering, University of Florida, Gainesville, Florida

Technical Manual Writing, Short Course on

Date: February 6–17, 1961
Objective: Not yet established
For: Technical manual writers
Fee: $175.00
Address: Sam Houston, Engineering Ext., University of California, Los Angeles, California

Traffic Planning Conference

Date: November 7–8, 1961—annual
Objective: Exchange of information between agencies and individuals involved in Traffic Planning
Fee: $10.00
Address: Civil Engineering Dept., Texas A. and M. College, College Station, Texas

Utilization of Engineering Personnel

Date: Spring, 1962

Objective: To promote more effective use of engineers and engineering technicians through discussion and demonstrations by experts in this field

For: Anyone interested in the effective use of engineers and engineering technicians

Fee: $17.50 plus meals and housing

Address: Continuing Education Service, Kellogg Center, Michigan State University, East Lansing, Michigan

X-ray Analysis, 10th Annual Conference on Applications of

Date: July 26–28, 1961 (date not definite)

Objective: New uses of X-ray analysis in technical field (non-medical)

For: Metallurgists, engineers—users of X-ray analysis

Fee: $25.00 per person

Address: Wm. M. Mueller, Metallurgy Division, Denver Research Institute, University of Denver, Denver 10, Colorado

CDEF WON'T DIE

"Engineering Faculty Recruitment, Development, and Utilization" was the final report of the Committee on Development of Engineering Faculties and the Committee is no longer active, but the studies it started will be continued. President E. A. Walker, in recognizing three major aspects of CDEF's work which should be continued, has made the following assignments:

1. *To ECAC*—faculty recruitment. Employing faculty members is a chore of deans, and so it rightfully is a concern of theirs and they should assume responsibility for needed follow-up activities and recommend logical action programs.

2. *To Educational Methods Division*—faculty utilization. This might be primarily a statistical study, discovering and recording educational experiments (complete or in progress) that relate to more efficient and effective utilization of engineering faculties.

3. *To a New Faculty Development Committee*—development of faculties. This new committee is charged with the responsibility of considering necessary procedures and research that should be undertaken to improve the development of our engineering faculties.

NEW SOURCE OF FUNDS FOR FOREIGN EDUCATIONAL AID

The State Department has announced that U. S.—owned foreign currencies are now available "as a means of responding constructively to requests from American educational institutions for U. S. Government assistance in continuing, expanding, or initiating programs of their own which would contribute to the cultural and educational development of foreign countries as well as to the broader objectives of international educational exchange." This is the result of a recent amendment in Public Law 480, and the Department sees in it "an opportunity to supplement with U. S. Government-owned foreign currencies, the dollar resources of American Universities for the attainment of common objectives in the field of cultural and educational development in foreign countries."

This is a significant new development and one which has important implications for the international program of U. S. educational institutions and organizations. Institutions interested in obtaining such currencies or in suggesting specific ways in which the funds might be used are encouraged to address their inquiries to: The Department of State, Bureau of Educational and Cultural Affairs, Washington 25, D. C.

Some Definitions

The following definitions are some that were approved by a steering committee appointed by the American Association of Collegiate Registrars and Admission Officers (AACRAO). This list was published in the September issue of the Technical Institute Division *Newsletter* and is reproduced here in the belief that the entire membership of the Society will find it interesting. The JOURNAL owes its thanks to the Technical Institute Division for making this material available.

COURSE, TERMINAL: Usual designation of a course, especially a course offered in a junior college, or technical institute, which is practical or technical in content, as opposed to courses designed to meet standards for academic credit courses; credit is usually offered toward the associate degree and may be applicable in whole or in part at some institutions toward the bachelor degree.

DEGREE CREDIT: Units of credit which can be applicable toward the associate, bachelor, or higher degree; such credit when earned in an occupational or terminal program in a junior college, or in a technical institute program, may be applicable toward only the associate degree, although it may also be applicable in whole or in part toward the bachelor degree in some institutions.

DEGREE-CREDIT STUDENT: One whose current program in an institution of higher education consists wholly or principally of work which is normally creditable toward an associate, bachelor, or higher degree.

INSTITUTION OF HIGHER EDUCATION: Includes all institutions offering educational instruction above the level of the secondary school, specifically junior colleges, colleges, universities, graduate schools, professional schools, technical institutes, teachers colleges, and normal schools, listed in Part 3 of the Directory of Higher Education of the U. S. Office of Education.

JUNIOR COLLEGE: A post-high school institution offering a program of less than four years, normally two years, which may be of a terminal nature or preparation for further education in college or university, or both, and which grants an associate degree in most cases, listed in Part 3 of the Directory of Higher Education of the U. S. Office of Education.

OCCUPATIONAL (or TERMINAL) CURRICULUM: One which, extending not more than three years beyond high school, is designed to prepare for immediate employment in an occupation or cluster of occupations. It is not designed as the equivalent of the first two or three years of liberal arts education or of pre-professional training, although the credits earned are normally creditable toward an associate degree and may be acceptable, in whole or in part, toward a bachelor's degree in certain institutions of higher education if the student changes his educational objective.

OPEN-ENDED CURRICULUM: An occupational or terminal curriculum offered in a junior college or technical institute designed in cooperation with one or more four-year colleges or universities in order that credits earned may be applicable, at least in part, toward the bachelor degree.

STUDENT, CLASSIFIED: One who has fulfilled the matriculation requirements and is pursuing an associate, bachelor, or higher degree program. Referred to by some colleges as a regular student, a member of one of the regular classes, or as a degree credit student.

TECHNICAL EDUCATION: A type of education which may be offered in a technical institute, as a junior college, or other institution of higher education, between that of the skilled craftsman and the professional engineer; credits earned are normally applicable toward the associate degree.

TECHNICAL INSTITUTE: An institution or division of an institution of higher education primarily offering instruction in one or more branches of technology frequently leading to an associate degree, and listed in Part 3 of the Directory of Higher Education of the U. S. Office of Education; credit earned may be applicable in whole or in part toward the bachelor's degree in some institutions.

TECHNICIAN: A worker on a level between the skilled trade worker and the professional engineer; his technical knowledge permits him to perform many of the duties formerly assigned to the graduate engineer; he may design the mechanism, compute the cost, write the specifications, organize the production, and test the finished product; his formal education is a recognized function of higher education, usually provided in the junior college or technical institute.

SUMMER INSTITUTES ON NUCLEAR ENERGY

Sponsored by the American Society for Engineering Education and the Atomic Energy Commission

The following programs in nuclear engineering are proposed to be offered during the summer of 1961. One 8-week or two 4-week programs may be attended. Application blanks and further information may be obtained from deans of engineering or from J. W. Seyler, Assistant Secretary, ASEE, University of Illinois, Urbana, Illinois. Applications should be in by February 1 but will be considered if received by February 15.

Eight (8) Week Programs	*Location*	*Dates*
Basic Institute	North Carolina State, Raleigh, North Carolina	June 19–August 11
Advanced Programs Thermonuclear Theory	University of Michigan, Ann Arbor, Michigan	June 26–August 18
Reactor Theory	Pennsylvania State University, University Park, Pennsylvania	June 19–August 11
Four (4) Week Programs		
Advanced Programs Reactor Theory	North Carolina State, Raleigh, North Carolina	June 19–July 14
Reactor Laboratory	Argonne National Laboratory, Lemont, Illinois	June 19–July 14
Reactor Experimentation	Stanford University, Stanford, California	August 21–September 15

Candid Comments

This section is open to comments on articles in the JOURNAL or on engineering education in general. Send comments to the Editor, JOURNAL OF ENGINEERING EDUCATION, University of Illinois, Urbana, Illinois.

The Role of Liberal Arts

The study of the role of the liberal arts in engineering schools discussed by Mr. Herbert Miller in "Liberal Education and the Engineering Profession" (JOURNAL for October, 1960) is clearly an improvement in certain respects over previous studies, especially in defining more exactly the categories used. It would be interesting to know, however, on what basis the courses were classified, particularly those that were included in the liberal category.

If these courses were classified according to catalog title and description, there is of course a possibility of error no matter how carefully the categories themselves were defined. Obviously a course title or even a brief catalog description is not as accurate and reliable an indication of content as the label on a can, for example. Mr. Miller says only that "those subjects which are clearly liberal are so labelled."

Also, the study discussed apparently followed the earlier "appraisals" mentioned in the article in concentrating on the "more quantitative aspects" of the problem (to borrow a phrase from Mr. Miller). It is important to know that the "liberal component" in engineering curricula has shrunk from an estimated 27% (or 28.8%) in 1870 to an estimated 13.4% today. But what about the *quality* of the liberal component?

A percentage decrease in liberal component doesn't mean necessarily that the education is proportionately less successful in giving students "mastery of the social skills," or in enabling them to "see life as a whole, integratively and meaningfully," or in accomplishing any other aim. And conversely, no particular percentage increase in the liberal content will guarantee that engineering students receive the education in the humanities and social sciences needed to become responsible citizens and successful human beings.

Mr. Miller's facts and conclusions are interesting and useful, as far as they go. But it is important also to recognize that "tabular representations of the curricular components" of thirty or any number of representative schools of engineering do not by themselves reveal very much about the actual "role of the liberal arts" in engineering education. Such information provides only a small part of the evidence needed either to define accurately the dimensions of the problem or to work intelligently for a solution.

WESLEY HUNNER
Humanistic-Social Department
University of Washington
Seattle 5, Washington

Engineering Education in Pakistan

The May, 1960, issue of the JOURNAL was devoted to discussions of the situation and the problems of engineering education in countries outside the U. S. Dean C. J. Freund has very faithfully expressed his views on the social customs and the general working of the departments in Pakistan. Situations and social customs vary from country to country, and it is always interesting to read the ideas of visitors from one region of the world to another. A host of popular magazines carry stories of one or more visits to distant lands, and perhaps it would have been more appropriate if Dean Freund's article were published in some such magazine rather than in a journal solely concerned with engineering education. The poverty and the hospitality in Pakistan, the transport system not yet completely modernized and people getting late to appointments as a consequence, and comparatively slow rate of

progress are some of the things mentioned in the article, which will, of course, look strange to a visitor from America. It is good to point these out for the benefit of later visitors. However, I must point out that every possible effort is made in Pakistan to make the visiting advisor feel at home. For example, Dean Freund stayed in Lahore in a palatial house with lawns, like of which I did not see many even in the U. S. With it there is always a retinue of servants around to do all the household work.

If Dean Freund or any visiting expert could comment and make suggestions on our problems of engineering education as well, it would be of immense use to us. Our output of engineering graduates has increased many-fold and so has the number of engineering institutions since the establishment of our country, and we too have the problem of shortage of engineering teachers. To solve the ensuing problems, we do need and appreciate help and advice from friendly countries who are ahead of us in the race for progress.

October 22, 1960.

Afzal Kazi
NED Engineering College
Karachi, Pakistan

Citizen Soldiers

In the October Journal, Herbert Miller in his article on "Liberal Education and the Engineering Profession" speaks of the relationship of ROTC to other subject matter. He says in part, "Many schools state they are interested in producing citizens; not one states that it is interested in producing soldiers."

The implications behind such a statement cannot be truly indicative of the significance of civilian-military education in our colleges and universities. In the type of society in which we live, the civilian institutions have always had the responsibility to provide citizen-soldier leaders, whose influence has been paramount in every period of armed conflict in which this country has engaged. This philosophy is expressed in the Official Register of Princeton University, 1959–60: "For the individual, training and leadership and understanding of the nation's political and military problems are essential to good citizenship. From Princeton's point of view, providing her share of military leaders continues to be an important part of her tradition of service to the Nation."

In recognition of the greater need for scientific and engineering personnel in modern warfare, engineering educators need always to preserve a broad viewpoint of their responsibilities in this regard: to ensure a steady flow of graduates to both the regular and reserve components of the military establishment. To think otherwise is an invitation to disaster.

J. D. Strong, *Colonel*
United States Army, Retired,
Alexandria, Virginia

NEW PH.D. PROGRAM AT NYU

The Graduate Division of New York University's College of Engineering will increase "the depth and scope" of its program in nuclear engineering beginning this fall, Dr. John R. Ragazzini, dean of the College, has announced.

Under the expanded program, the College will now offer the degree of doctor of engineering science for students majoring in nuclear engineering. Since 1955 it has granted the degree of master of nuclear engineering.

NSF Summer Institutes in Engineering

This summer the National Science Foundation will help 20,000 high school and college teachers of science, mathematics, and engineering go back to school to take a new look at the subjects they teach and the ways they have been teaching them.

Grants totaling nearly $22.7 million to 260 colleges and universities were announced today in support of 395 summer institutes in 1961 as part of the Foundation's efforts to increase the classroom effectiveness of teachers.

Summer institutes offer teachers study opportunities in courses especially designed to (1) refresh their knowledge of fundamentals, (2) acquaint them with recent developments, and (3) familiarize them with new approaches in presenting subject matter.

Thirteen of the Institutes offered in 1961 will be in the general field of engineering. These are listed below.

Oklahoma State University, Stillwater, Oklahoma

Institute in Heat Transfer and Gas Dynamics for teachers of mechanical and aeronautical engineering. Nine weeks, June 2 to August 5. Eight semester hours' graduate credit. Director: J. H. Boggs.

University of Arizona, Tucson, Arizona

Institute on Space Mechanics for teachers of mechanical and aeronautical engineering. Ten weeks, June 12 to August 10. Nine semester hours' credit. Director: M. R. Bottaccini.

University of Illinois, Urbana, Illinois

Institute on Electronics Technology and Mechanical Technology for teachers of electronics and mechanical technology in technical institutes and junior colleges. Eight weeks, June 19 to August 12. Graduate credit available. Director: Jerry S. Dobrovolny.

Stanford University, Palo Alto, California

Space Technology (Rockets) for present college teachers with good backgrounds who wish to learn the specialty. June 26 to August 5. Six units of graduate credit available. Director: Howard SieFert; write to Lyman Nickel.

University of Houston, Houston, Texas

Mathematics and Electronics for technical institute and junior college faculty. Eight weeks, June 26 to August 18. Six to seven semester hours of credit if desired. Director: H. Curry.

Iowa State University, Ames, Iowa

Properties of Materials. July 13 to August 23. Eight quarter credits at the graduate level. Director: Glenn Murphy.

University of Missouri, Columbia, Missouri

Basic Engineering Subjects for teachers of junior colleges and 4-year non-engineering colleges. Courses available: statics, dynamics, fundamentals of electricity, thermodynamics, mathematics, science. Eight weeks, June 12 to August 4. Director: Karl H. Evans.

Bucknell University, Lewisburg, Pennsylvania

The Engineering Sciences for physics and engineering teachers in junior colleges and liberal arts colleges with pre-engineering programs or 3–2 programs. Two courses selected from chemical engineering, civil engineering, electrical engineering, mechanical engineering. Graduate credit available. June 26 to August 4. Director: Charles H. Coder.

Colorado State University, Fort Collins, Colorado

Fluid Mechanics. June 19 to August 11. Graduate credit available. Director: James R. Barton.

Stevens Institute of Technology, Hoboken, New Jersey

Thermodynamics, science of materials, transport phenomena, matrix-tensor methods. Graduate credits available. July 10 to August 18. Director: Robert H. Seavy.

Louisiana Polytechnic Institute, Ruston, Louisiana

Solving Engineering Problems on Electronic Computers. Courses on linear programming, matrix theory, numerical analysis, programming of high speed digital computers, heat transfer, reservoir engineering, unit operations, electrical engineering, vibrations, structures. Graduate credit available. Director: Melvin A. Nobles.

Illinois Institute of Technology, Chicago, Illinois

Mechanics and Related Courses for college teachers. Eight semester credits, graduate level. Eight weeks, June 26 to August 18. Director: P. Chiarulli.

University of Arkansas, Fayetteville, Arkansas

Basic Engineering Subjects for junior college teachers and others who teach basic engineering subjects to students who will transfer to accredited engineering colleges. Director: R. C. Wray.

Tuition and fees are paid for all teachers attending institutes. Teachers receive stipends of not more than $75 a week for the duration of the training, allowances for travel, and allotments for dependents up to four in number.

Participants are chosen by the staff of the institute, NOT by the National Science Foundation. Inquiries and applications for participation should be addressed to directors of the institutes.

RWI'S 13th ANNUAL COLLEGE–INDUSTRY CONFERENCE "DEVELOPING AND MAINTAINING PROFESSIONAL CLIMATE"

University of Cincinnati, February 2–3

Tentative Program

Thurs. A.M.—Hotel Alms

9:30 WELCOME from the University of Cincinnati

9:40 KEYNOTE: "What is Professional Climate?"
Is professionalism in engineering the same as in other fields? How can professionalism be measured? The current and future importance of a professional attitude to the individual and to organizations

10:15 EXPERIENCE: Some reflections on . . . .
1. What a Company Has Done
2. What a Consulting Firm Has Done
3. What a Government Agency Has Done
4. What a University Has Done

12:30 LUNCHEON—Professional Climate in the Community

Thurs. P.M.—Engineering Society Headquarters—Herman Schneider Foundation Building

1:50 5. Professionalism and Unionism

2:15 DISCUSSION PERIOD: Group Sessions with speakers of the day for further development of above topics

6:15 SOCIAL HOUR—Hotel Alms
7:00 BANQUET—Program by Cincinnati Chapter, Society for Advancement of Management

Fri. A.M.—University of Cincinnati Campus

9:30 OPINION RESEARCH—Professionalism in Industry. A report on the NSPE Survey
10:20 FACULTY IMPRESSIONS—A report from Faculty Members in Summer Employment. By the RWI Committee
10:45 DISCUSSION—Group reports; open discussion
11:30 THOUGHTS FOR THE FUTURE—Summary of Conference
12:30 LUNCHEON—Professional Climate in ASEE

Speakers Will Include:

Stanley Learned
Chairman, Executive Committee
Phillips Petroleum Company

James M. Jagger
Vice President, Personnel Dir.
Arthur D. Little, Inc.

Francis F. Bradshaw
Management Consultant
Advanced Management Institute
General Electric Company

Hugh L. Rusch
Vice President
Opinion Research

J. Gibson Pleasants
Vice President, Research & Development
Procter & Gamble Company

Timothy E. Shea
Vice President, Engineering
Western Electric Company

Capt. L. E. Root
Asst. Chief of Engineering
Bureau of Yards & Docks
United States Navy

J. Morley English
University of California, Los Angeles
Chairman, Professional Climate Committee, RWI–ASEE

Eric A. Walker, President, ASEE
President
Pennsylvania State University

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For copy of the final program and reservation forms write: College-Industry Conference Committee, University of Cincinnati, 101 Baldwin Hall, Cincinnati 21, Ohio.

Section Meetings

Section	*Location of Meeting*	*Dates*	*Chairman of Section*
Allegheny		April, 1961	E. R. Schatz, Carnegie Institute of Technology
Illinois-Indiana	Ill. Inst. of Tech.	May 13, 1961	Peter Chiarulli, Ill. Inst. of Tech.
Kansas-Nebraska	Kansas State U.	Oct., 1961	M. H. Snyder, Univ. of Wichita
Michigan	Michigan State U.	April 22, 1961	C. E. Cutts, Mich. State Univ.
Middle Atlantic	Drexel Inst. of Tech.	Dec. 3, 1960	F. L. Singer, New York Univ.
Missouri-Arkansas	Saint Louis Univ.	April 8, 1961	V. T. Allen, Saint Louis Univ.
National Capital Area		Jan. 10, 1961	Geo. H. Hickox, Ft. Belvoir, Va.
New England	Brown University	Oct., 1961	E. F. Littleton, Tufts Univ.
North Midwest	Marquette Univ.	Oct., 14–15, 1960	R. J. Kipp, Marquette Univ.
Ohio	Ohio State Univ.	April, 1961	R. S. Green, Ohio State Univ.
Pacific Northwest	Univ. of Washington	May, 1961	H. P. Mittet, Univ. of Washington
Pacific Southwest	Stanford University	Dec. 28–29, 1960	R. J. Parden, U. of Santa Clara
Rocky Mountain	University of Wyoming	Apr. 28–29, 1961	A. J. McGaw, Univ. of Wyoming
Southeastern	Univ of Mississippi	April 20–21, 1961	W. J. Seeley, Duke Univ.
Southwest	Univ. of Tulsa	Apr. 7–8, 1961	G. B. Tims, Jr., Lamar State College
Upper N. Y.-Ontario	Clarkson College		R. D. Larsson, Clarkson College

Mid-Winter Meetings–1961

Cooperative Education — Jan. 23–25 — University of Detroit

Information: D. C. Hunt, Director of Coordination and Placement, University of Detroit, Detroit, Mich.

Engineering Graphics — Jan. 19–21 — University of Wichita

Information: A. C. Risser, Head, Engineering Drawing, University of Wichita, Wichita, Kansas

College-Industry Conference — Feb. 2–3 — University of Cincinnati

Information: C. Wandmacher, Assoc. Dean of Engineering, University of Cincinnati, Cincinnati, Ohio

The Role of Engineering Education in Latin America

F. M. TILLER

Dean of Engineering
University of Houston

Latin America is a 'Forgotten' Area

From a diplomatic viewpoint, Latin America is a 'forgotten' area in relation to its importance to the United States. The relentless pressure of Russia has forced us to place a great proportion of our emphasis in foreign assistance on countries far from our borders. Ultimately the proximity of the growing, restless continent to the south will make it of greater importance to our welfare than more remote regions.

With approximately 175 million people in Latin America, a rate of growth of 2.5–3.0% per year is being approached. Calculate 1.03^{100} with the aid of your slide rule, and the answer will be 20. Multiply 175 million by 20 and you have 3.5 billion people one hundred years hence in Latin America. Mexico at 3% compounded annually will reach 100 million in about 35 years. This increase alone in Mexico equals one-third of the present total population of all of Latin America. Many of us will live to see a half billion inhabitants in the southern half of our hemisphere. Our children may see the billion mark passed. Today's generation cannot look complacently on the growth of an over-populated region on its borders with all the attendant problems.

Foreign Aid in Latin America

During the period 1948–1958, about 1.3% of the total non-military expenditures under the Mutual Security Program were spent in Latin America. Half of this amount was utilized in Bolivia, and two Central American nations, Guatemala and Honduras, leaving less than 0.7% for the remaining 17 countries. By contrast, the two small countries of Laos and Cambodia were awarded as much dollar aid as all of Latin America. In addition to the imbalance in non-military expenditures, funds spent abroad for military purposes have been largely outside of the Western Hemisphere. During 1958, even though very little non-military aid went to Europe, a total of $1.85 billions of military funds was spent by the U. S. in the European theater. Indirectly, this had a large impact on the economy and was approximately 27 times the total non-military expenditures in Latin America. A decrease of four per cent in military aid to Europe would yield sufficient funds for doubling our efforts in the Western Hemisphere. It is reasonable to inquire if Europe has not sufficiently recovered to assume more of the burden of its own protection.

The Case of the Panama Hat

Latin American countries depend heavily on foreign trade, 50% being with the U. S. A small change in our buying habits can profoundly affect the economy of countries and regions within countries of our Southern neighbors.

Consider the Panama hat which is manufactured in Cuenca and Montechristi, Ecuador, not in Panama (and not under water). Within a decade imports to the U. S. dropped from $6 million to $1.5 million. At salaries of about $200 a year, the livelihoods of 25,000 were wiped out. With other work unavailable, the region around Cuenca entered a severe depression which I had an opportunity to observe in 1958. It is difficult to explain the friendly feeling of the

the Southwest Section of the ASEE, April 30, 1960.

U. S. and the important role of competition under these conditions. When the U. S. sneezes, a small friendly country like Ecuador catches pneumonia. As the most affluent member of the Organization of American States, we cannot avoid assuming responsibility for the economic well-being of our sister republics.

The Engineers Who Aren't There

According to "Open Doors," the Institute of International Education publication, there were nine U. S. engineering professors officially present in South America in 1958. With $3–$4 billion being appropriated yearly under the Mutual Security Act, the utilization of only nine U. S. engineering professors in South America represents gross neglect of the very basis of our industrial might as reflected in engineering and science.

While our engineering enrollments are dropping, Russia plans to increase its engineering graduates to two to three times our numbers. Responsible authorities do not believe the Russian economy needs such large numbers of new graduates. Inevitably we must conclude that Russia is preparing its engineers for export. If we assume that half of the world lacks engineers, then in proportion to the numbers in the U. S., a need for 10 million engineers can be demonstrated. By meeting the challenge of this potential and enormous demand for engineers, Russia could accomplish its objectives more directly than in any other manner.

The U. S. is Mildly Active

While there are a large variety of U. S. activities of varying quality in Latin America, they can be classified under the following headings for the purposes of this discussion:

1. Diplomatic Service
2. Armed Services
3. International Cooperation Administration
4. Fulbright Commission
5. Private Foundations
6. Private Business

Activities involving normal diplomatic relations and many aspects of the Armed Services represent a necessary and continuing part of the U. S. government. The International Cooperation Administration is the newest arm of the State Department devoted to giving aid to underdeveloped countries. Much of its activities, as well as those of private foundations, are concentrated in public health, agriculture, elementary education, and development of sub-professional skills. A few ICA programs are concerned with engineering education, road building, and related engineering activities.

A vast amount of effort goes into medical programs, religious activities, and other commendable and appealing areas. Fulbright grants are almost exclusively in the fields of literature, language, and social sciences with virtually no requests for scientists and engineers. The Kellogg Foundation has a fine program in Latin America in which universities are assisted in agriculture, forestry, dentistry, nursing, hospital services, medicine, and public health. An article entitled "Funds Sought for Medical Missions—$100,000 is Texas Goal of Group in Overseas Project" appeared in the Houston *Post* on May 7, 1959. A similar effort devoted to an overseas technical education mission is unheard of. It is rather paradoxical that many of our efforts produce conditions favorable to rapid population growth without corresponding economic growth. Failure to balance humanitarian works with engineering and business education can only end with inhumanitarianism.

It is easier to spread a little DDT than it is to produce educated engineers and businessmen.

Increased Production Fundamental

The rebellion in Cuba, past Communist successes in Guatemala and British Guiana, the Perón regime in Argentina, and the stoning of Nixon in Venezuela all give evidence of unrest. If present trends continue, development of either communism or intense nationalism antagonistic to the U. S. will become an increasing possibility. Although it is unwise to attempt sweeping generalizations, poverty probably represents the single most important adverse factor in the

Latin American scene. Increase in production of goods is fundamental to any solution of basic problems.

The difficulty of effecting a solution for increased production is a problem with many facets. Lack of common markets, insufficient capital, staggering geographical difficulties, government instability, unwise economic policies, inflation, government monopolies, and lack of confidence in native university graduates serve to confuse the issue. It is my contention that while all of these factors are of importance, the basic and fundamental problem is the development of a competent engineering and business community. Without the requisite engineering and business knowledge in the minds of Latin Americans, no solution to their economic problems can ever be realized.

One bright spot in our relation to Latin America is reflected in funds placed abroad by United States business. Exceeding 8.8 billions, private long-term investment in Latin America (1957) represented one third of our total world wide interests. This compares to 8.3 billions invested in Canada (1957) and about 50 billions per year of gross private domestic investment.

Ecuador, a Friendly Example

Problems vary widely in passing from the small countries of Central America to large nations like Brazil and Argentina. With an average per capita income of less than one-tenth of that in the U. S., a small country of a million people will have a national income about equal to that of a county having 50,000–100,000 population. The problem of economic development must be approached in full realization of existing limitations.

Ecuador with a population of 4 million has an annual income of about $600 million, which about equals the income of Fort Worth, Texas. The national government operates on an annual budget of $130 million, which is about equivalent to expenditures of the City of Houston and the Houston Independent School District. With these meager funds, schools, roads, armed forces, and diplomatic missions throughout the world must be maintained. It is little wonder that not a single paved road leads from the capital city of Quito and that the dedication of a small bridge over the Daule River warranted the presence of President Ponce and the issue of a commemorative stamp.

Foreign trade amounts to about $100 million and forms a major fraction of income in the commercial centers. Less than 8% of foreign commerce is with neighboring countries. By contrast, there is more trade with Germany. The small quantity of trade with neighbors is due primarily to lack of manufactured products available for exchange.

Ecuadorian people appear to be basically friendly toward the U. S. in sharp contrast to many areas of the world. The country is enjoying a period of relative stability both politically and economically, and the sucre is one of few foreign currencies which has not experienced inflation over the past few years.

In spite of the apparent calm, evidences of Communism can be seen everywhere in the form of the hammer and sickle. During the second week of my visit to Guayaquil in 1958, a group of Communist students complained to Dean Celleri of the Faculty of Sciences about my activities.

In numerous conversations, restrained but potentially explosive criticism of the U. S. was voiced by senators, professional people, and university officials. There is confusion concerning the responsibility of the U. S. with respect to economic problems both among Ecuadorians and Americans. The U. S. seeks to help in many channels, and Ecuador struggles to frame reasonable requests for aid. Neither seems to recognize that scientists and engineers are necessary in large numbers for the solution of Ecuadorian problems. In the pattern which has evolved, the industrial strength of the U. S. as based on science and engineering has not become an important factor.

Perusal of Ecuadorian newspapers discloses daily crises in road building, shortages of electrical power, agricultural diseases, contraband from Colombia, and a variety of other vexing situations. Solutions for each separate problem are demanded of the poverty stricken government without realization that none of the problems can be solved until a funda-

mental scientific and engineering base is provided.

Most of the economic difficulties can be traced to an almost complete absence of trained scientific manpower. In proportion to the U. S., Ecuador should graduate 600 engineers yearly on top of a base of 15,000–20,000 engineers and scientists. Facilities for training in engineering and science are inadequate.

Only technical personnel from the U. S. can solve the many scientific problems of Ecuador. Other than S. S. Steinburg, retired Dean of Engineering at the University of Maryland and presently in Brazil, who made a cursory study of the overall educational picture, I was the first American engineering educator to actually review the programs of the Faculties of Chemistry and Sciences in Quito and Guayaquil. While it seems incredible that the U. S. has not extensively utilized its wealth of engineering talent to further the educational programs of Ecuador and Latin America in general, nevertheless such is the truth.

It is not diplomats, lawyers, sociologists, or musicians but engineers who must accept responsibility for the lack of participation of its members in hemispheric development of engineering education.

A Latin American Views History

History is like a gun barrel; it depends upon which end is viewed. I am sure we all think that expansion of our country from the Mississippi River to the Pacific was natural and just, in fact, a God-given prerogative. I am sure we all feel hurt at references to the U. S. as imperialistic. But let's look down the other end of the gun barrel.

Recently a prominent officer of a Mexican engineering society spoke in Houston. He was educated in the U. S., friendly to our country, and an attractive person. After the meeting a discussion ensued on Latin American attitudes toward *Norteamericanos,* and our Mexican friend posed an interesting question. What country in modern times has lost more territory than any other? The answer was simple, Mexico to the U. S.; and qualified by the statement, more territory than Russia has taken from anyone.

Santayana said those who do not understand history are compelled to repeat it. We must also understand how other people, rightly or wrongly, view history if we want to sweep away the gray clouds of mistrust and misunderstanding.

Understanding is Fundamental

Knowledge of geographical, political, and social aspects of Latin America is essential to an intelligent approach to a solution of its problems. South America suffers from mountainous terrain, rivers that flow away from the coast, mal-distribution of rainfall, malarial jungles, and incredibly difficult transportation problems. The myth of agricultural fertility of the Amazon must be discarded. If a great proportion of our population were concentrated in the Appalachians and Rockies and the fertile plains near the Atlantic were washed into the sea, we would be in a less favorable position, but one similar to the present situation in South America.

The Spanish heritage of Latin America is based upon art, literature, religion, and military heroism. Absent is emphasis on business and science. The Spanish kingdoms (Aragon, Castille, Cataluña, etc.) of the pre-industrial sixteenth and seventeenth centuries encompassed the largest empire known to man. The might of Spanish legions, the art of Goya and El Greco, the literature of Cervantes, the humanity of Las Casas represented a golden age. While the decline of Spain with the inevitable effect on the colonies had many facets, there are several I should like to mention.

Spain, as a theocratic federation of independent kingdoms, through its monarch devoted substantial energy and thought to Catholic Christianization of the natives in the new world. Although thwarted by grasping conquistadores, the court, urged on by the Spanish church, was benevolently unique in issuing a bewildering stream of directives aimed at aiding the downtrodden Indians. While Las Casas and Sepulveda debated the just treatment of the Indians and their position as his Spanish majesty's loyal subjects, the English prepared to annihilate the aboriginal inhabitants of North America. While the friars and

conquistadores built a lavish old-world empire based on the labors and suffering of the Indians, the English mastered the seas, looted the new world cities, and knighted their privateers of the Spanish Main. While Spanish governments misunderstood inflation due to imports of gold, the British founded the Bank of England on pirated treasure. The zeal of the Spanish for continuation of past glory obscured the works of Newton, Leblanc, Watt, and Solvay. The industrial revolution arrived to find the British and French ready and the Spanish ill-prepared to understand the new and all-powerful force. Its Armada defeated on the seas in the 16th century, its army routed for the first time in centuries at Rocroy in the 17th century, its traditions unable to harmonize with the steam engine in the 18th century, its political decline in the 19th century, all these things played their silent roles in yielding to the inevitable maladjustment of peoples in today's underdeveloped Latin American countries. To turn the path of Latin American history is a task of the 20th century.

What can be Done?

Since engineering education is essential to progress of underdeveloped countries, it would seem that colleges of engineering and technical societies would be logical agents to assume responsibility for strengthening our present activities.

I should like to describe a program which is beginning to function in Ecuador and make suggestions concerning possible courses of action. In 1958 I recommended that engineering education be emphasized in Ecuador and received support from the Minister of Education, the Universities, and the Embassy. After a series of frustrating experiences, the Organization of American States in combination with the Fulbright Commission supplied sufficient funds to send two chemical engineering professors to Ecuador. They were so successful in their activities that the *Facultad de Ciencias Quimicas y Naturales* in Guayaquil completely altered its chemical engineering curriculum along modern lines. It is hoped that increased funds will make possible long term continuation of the project.

I recommend that engineers support the following measures:

1. Increased emphasis at local and national meetings on underdeveloped countries and foreign policy. Desirable examples include the A.I.Ch.E. meeting in Mexico, the good-will trip of two NSPE members to South America, the cooperation of EJC with the Pan-American Federation of Engineering societies (UPADI), and the program at the ASEE national meeting sponsored by the International Relations Committee.

2. More contact between U. S. engineering educators and their counterparts in Latin America. Deans and professors should seek travel grants to visit specific universities. I am confident that every such trip would result in important ties being established.

3. An educational mission to Latin America. The International Relations Committee has submitted a proposal to the ASEE Executive Council for a mission similar to those to Russia and India. Properly planned such a mission could result in desirable publicity, education of Latin American and U. S. officials, and desirable contacts.

4. Establishment of cultural contacts between Latin and North American universities. Formation of Latin Affairs Committees and administrative support for increased exchange of faculty and students could have a significant effect.

Conclusion

In concluding may I say that on our shoulders rests a grave responsibility to channel a tiny fraction of our efforts toward improving hemispheric engineering education.

Observations of Engineering Education in Some South American Countries

W. LEIGHTON COLLINS

Professor of Theoretical and Applied Mechanics, University of Illinois
Secretary of the American Society for Engineering Education

This article does not pretend to be a discussion of the good or bad features of any engineering educational system. It is presented with the idea of pointing out significant differences from what is commonly found in U. S. schools, so that with these differences in mind, the reader might better understand the resolutions adopted at the Pan-American Congress on Engineering Education.

The Secretary of ASEE spent two months in South America last summer. The Executive Board granted him leave for one month, provided Assistant Secretary Jimmy W. Seyler could replace him at no cost to the Society; the other month was his usual (but seldom taken) vacation. The particular circumstances leading to the trip were to represent ASEE at the First Pan-American Congress on Engineering Education at Buenos Aires and a request from the State Department to serve as a specialist on engineering education at the National University of Asuncion, Paraguay, for one month. The Ford Foundation graciously provided transportation under its program for foreign travel and study. Six schools in four countries were visited.

The official EJC-ASEE-ECPD team was composed of W. L. Everitt, H. K. Justice, F. C. Lindvall, R. A. Morgen, J. H. Sams, and B. R. Teare, Jr. Each was responsible for a paper in the areas of engineering education originally designated. Additional official delegates from the U. S. were J. L. Meriam and W. Leighton Collins. J. L. Meriam and R. E. Stiemke presented additional papers and F. W. Zur Burg presented a discussion. H. H. Armsby, Robert Armsby, George Browne, B. T. Bogard, W. H. Carson, R. H. Morris, P. F. Pike, L. F. Stutzman, D. L. Trautman, N. A. Weber, L. K. Wheelock, and Josef Wischeidt were others from the U. S. in attendance. Deans H. G. Conn and R. R. McLaughlin were the representatives from Canada presenting information on its engineering schools.

The resolutions passed by the Congress and recommended to UPADI for approval are on page 331. The papers presented by the EJC-ASEE-ECPD team also are in this issue of the *Journal* so that each of you will know what was said to our neighbors to the south, and north. A general story about the Congress is on page 329. Dean Tiller's article on page 321 presents still another aspect of our relations to Pan-American colleges of engineering.

Almost all professors in Latin American schools of engineering are on a part-time basis. This includes the basic sciences as well as the strictly engineering subjects, though it is more prevalent in the latter group. Further, most universities are divided into "Faculties" which are located in different parts of the city and which function independently, employ their own staff, etc. For example, physics might be taught in the "Faculties" of medicine, science, engineering, and architecture by different people in different laboratories. That is why the need for full-time staff members is so urgent and is rated as a major problem.

Teaching salaries are usually so low that one cannot afford to teach full-time. The part-time income is the "extra" that enables the professor to own a home, have a car, maintain a better living for his family, etc. Prestige, a desire to help young people, a desire to teach, and patriotism are other reasons causing peo-

ple to teach part-time. At some schools, however, it is firmly believed that the upper-class courses must always be taught by practicing engineers because that is the only way the student can find out what an engineer really does and how he does it. Professors frequently are appointed for a limited period of time, such as five years. As openings develop, they are advertised, and the man with the best record is appointed. When his term expires he again must compete for reappointment. The students have a voice in the selection because they frequently constitute as much as one-third of the group making the selection; the remainder might be one-third alumni and one-third faculty.

Most engineering students are also part-time. Having as many as 50% attending full-time probably is high. Most are earning a living and perhaps supporting families. The common six-year curricula thus usually are not completed in less than about eight years. The degree received usually is *ingenieur* and enables the recipient to immediately get his license and practice all aspects of his profession. Graduate work as we have it is unusual.

The students play an active part in all phases of administration. They usually are well organized and sometimes not only tell the faculty what courses to teach, but also what will be taught in a particular course. Occasionally there are "free" professors—professors the students want and get because they believe the "free" professor to be better qualified than the one regularly assigned. One reason for this high interest of students in administrative matters probably is that they are around the university more than a majority of the faculty and really might know more about what is going on.

The variation in secondary school preparation is great, undoubtedly greater than in the United States. Some come with college preparatory training, some with preparation for careers in business, some with teaching for elementary schools, etc. Consequently some institutions give entrance examinations, some take students as they come, and in at least one instance all entering students take a two-month pre-university refresher course in physics and mathematics which reduces the number continuing in engineering by about 50%.

The strength of engineering education in Latin America seems to be in theory. Laboratory instruction is not as extensive as in U. S. and Canadian schools. This is why a second major resolution of the Congress pertains to the need for laboratory equipment. The fact that little research is done in engineering is also a contributing factor to the limited laboratory facilities.

Higher education is generally considered to be free in Latin American universities. There is no tuition and usually there are no text books to be purchased. Books are expensive, and appropriate translations into Spanish are just becoming available. For the same reasons, libraries usually are limited and homework is not extensive. Books in languages which cannot be read are not very helpful to students or staff, and is one reason why libraries are not used more extensively. The need for books and periodicals in Spanish frequently is mentioned as the third great need.

Out of town students must find their own housing and meals, though some schools do offer meals at less than cost.

Semester or quarter systems are little used. Most courses last for a school year. Following the conclusion of the term, several weeks to a month elapses for study time. Then the student takes his exam on the year's work. "Partial" exams at mid-year, though, are common. There is some dissatisfaction with this procedure because the student studies to pass the exam instead of learning the subject matter as the year progresses.

The need for humanities received much discussion at the Congress on Engineering Education. In view of opinions expressed at most institutions visited, that was surprising. A common evaluation was that engineering and the humanities or social sciences should be entirely separate; the engineer had to be given *all* the technical knowledge he possibly could be given in six years in order that he may be able to practice *entirely* on his own immediately after he gradu-

ates, since graduation usually is all that is required for licensing. This is quite a contrast to the U. S. concept that graduation is just one step in becoming an engineer and that some practice is required before qualifying as a professional engineer.

Many institutions are interested in exchanges of faculty members or in having faculty members from other schools teach on their faculties for a semester or year. Some schools also are interested in having U. S. professors come to South America during the U. S. summer vacations, for that is when they are in midwinter. No one knows just where the dollars will come from to accomplish such a plan, but U. S. teachers fluent in Spanish (or Portugese) suddenly might find summers south of the equator enjoyable and helpful.

We have much to share with our neighboring institutions to the south and individually and collectively we undoubtedly have some responsibilities. What are they and what can each of us do? What can and should ASEE be doing?

The Pan-American Congress asked ASEE to have the "Report on Evaluation of Engineering Education" published in Spanish, and ASEE did provide the delegates to the Congress with copies of its recent reports. It is hoped one set gets to each engineering school and that they will be studied. It is true, we have our own problems, but that does not mean that in 1960 we can neglect the problems of our neighbors. Teaching, research, and public service have been three factors frequently mentioned as important in evaluating a man for advancement. Perhaps "international service" now must be added to the list so that those who spend an occasional year or two abroad are not penalized for a lack of "local" contributions.

Appreciation is duly expressed to the Executive Board for granting permission to make the trip, to the Ford Foundation for providing travel funds under its Travel and Study Program, and to the Department of State, Bureau of Educational and Cultural Affairs, for the grant to serve as a United States Specialist.

FOUNDATION INVITES PROPOSALS FOR RESEARCH AND DEVELOPMENT ON NEW LABORATORY EQUIPMENT FOR U. S. SCHOOLS

Scientists and science teachers in colleges, universities, and non-profit organizations have been invited by the National Science Foundation, an independent agency of the Federal Government, to submit proposals for the development of prototypes of new laboratory equipment for use in the Nation's schools and colleges. Proposals judged most meritorious will be supported by the Foundation under a program designed to encourage the development of inexpensive and practical apparatus for use in the laboratory phases of science instruction.

Under the terms of this program, the Foundation will consider proposals for the design and construction of prototypes of improved equipment for lecture demonstrations, laboratory and field work at elementary, secondary, and college levels in mathematics, engineering, astronomy, earth and atmospheric sciences, physical and biological sciences, anthropology and experimental psychology.

Proposals, signed by the project director and a responsible officer of the sponsoring college, university, or scientific organization, should clearly describe the work to be done, give the qualifications of the personnel involved, show how the proposed device will be tested and eventually made generally available, and present a detailed budget. Support under this program will *NOT* be provided for the purchase of equipment for refurbishing school and college laboratories, or for commercial production of equipment or materials.

First Pan-American Congress on Engineering Education

R. H. MORRIS

Editorial Director, Power Engineering Magazine, Barrington, Illinois
Adapted from Power Engineering Magazine

Means and methods of improving engineering education, adapting it to the needs of individual countries and coordinating teaching methods among all engineering schools in the Western Hemisphere were outlined at the First Pan-American Congress on Engineering Education. The Congress was held in the Engineering College of the University of Buenos Aires, September 12 to 18, and was attended by over 200 delegates from 16 Pan-American countries.

The meeting was an outgrowth of many years' endeavor by the Engineering Education Committee of UPADI, the Pan-American Union of Engineering Societies. In the United States the UPADI member is the Engineers Joint Council. The Committee on International Relations of EJC, in joint meeting with the Committee on International Relations of the ASEE, cooperated on the U. S. program with Ralph Morgen, president of Rose Polytechnic Institute, as Chairman and coordinator of the project. Final participation was a joint effort of the EJC, ECPD and ASEE, with the financing made possible by a grant from the National Science Foundation.

The general theme and arrangement of the Congress is well outlined in the titles of the papers, covering the formal contribution of the U. S. Delegation. Working committees were set up following this outline. Each committee considered in detail similar contributions by delegates from all the countries and proposed a series of recommendations which was later submitted to the entire assembly.

Long range objectives and responsibilities of engineering schools throughout the hemisphere were cataloged thoroughly and with reasonable agreement among delegates with widely differing present-day standards. Thus the conference, which was to a large extent an inventory of present methods and standards, established a plane of reference upon which future conferences can build to bring about gradually increasing standards of professional education adapted to the needs of individual countries.

Aside from the active participation of various government agencies and the Organization of American States in the Congress was the wide acceptance of the principle of close cooperation and coordination with similar movements between the U. S. and Western Europe; namely, EUSEC and IAESTE. The former organization is concerned with engineering education and education standards and the latter with the exchange of upperclass engineering students between countries. Both of these topics were set aside for more detailed discussion and consideration at the UPADI meeting to be held the following week.

More than a score of resolutions or suggestions for action were passed. The most important immediate need of many countries is full-time teaching staff. The importance of this was summarized by Prof. J. L. Meriam as: "The success of a program in engineering education depends in the long run on the quality of its teaching rather than on the character of its supporting administrative framework and curricular structure."

A problem in all countries is the quality of secondary schools and the adequate preparation of entering college students. There is an immediate need for an inventory and evaluation of secondary schools and for methods of screening and selecting engineering students. Some countries place considerable reliance on aptitude and achievement tests, but these are questioned in many quarters. The

U. S. opinion as expressed by Dr. Morgen is: ". . . there are many who believe the excellence of the graduates of the Bachelor's level . . . bears a stronger relationship to the screening of students at entrance than to a variation in the presentation of subject matter . . . at colleges."

As in all international conferences, the matter of vocabulary is of major importance. In the educational field, good work on vocabulary standardization has been completed by EUSEC, a well-integrated program of educational cooperation between Western Europe and the U. S. Introduction of EUSEC activities into the Buenos Aires Conference will do much to promote future communication and understanding among the countries involved.

The University of Buenos Aires has been carrying on library activities and an abstracting service on educational literature, and they volunteered to carry on this activity for the Congress pending the establishment of a permanent headquarters, secretariat and international center for disseminating information and for cooperation with other international agencies such as UNESCO and the OAS.

Exchange of students and instructors among countries was universally approved, and the IAESTE program was endorsed.

B. R. Teare, speaking on graduate programs, emphasized: "Graduate study is desirable as preparation for research, development and design, especially for the newer advanced areas where the problems are growing progressively more complex; and for faculty posts in the engineering colleges." Industrial needs of many countries at the moment, however, are not of such a complex nature, and one of the basic needs of many would seem to be a well-coordinated system of vocational schools to supplement institutions of higher learning and meet the crafts and technician needs of the economy.

At the present time, civil and sanitary engineering tend to dominate Latin American circles, and there have been several recent conferences of the same general nature sponsored by the National Science Foundation and Cooper Union. Robert Stiemke reported on these conferences which to a large extent paralleled the Buenos Aires Congress but in more specific areas.

While UPADI activities in general skirt political problems, the question of legislation or licensing engineers is one which can hardly be sidestepped in any meeting of engineers. Practices and difficulties in the U. S. were thoroughly reviewed for the Congress by J. H. Sams. In part he said: "Various state boards are making every effort to develop more uniform practices . . . are . . . from time to time amending their laws . . . for more uniform requirements . . . so that an engineer desiring to practice in more than one state will not have too much difficulty . . . in additional states after he has registered in one. . . ."

Students play a much more important part in the control and operation of universities in the Latin-American countries than they do in the United States. A student from the University of Rio de Janeiro, representing the student council, made a plea that at least one student member from each UPADI country be invited to the next and subsequent congresses. This met with unanimous approval and will be incorporated in future programs, supposedly on the basis that the national delegations from each country will finance the venture.

While this report is confined largely to the U. S. participation in the Congress, the importance of the Congress on Engineering Education in the future should not be underestimated. It is proposed to publish all papers presented in English, Spanish and Portuguese in UPADI publications. At the moment, however, funds for this purpose are uncertain. In the meantime, copies of all papers, in their original language, will be on file at the headquarters of the Engineers Joint Council, 29 West Thirty-Ninth Street, New York City. The U. S. papers are printed on pages 338–374.

Resolutions of the First Pan-American Congress on Engineering Education, Buenos Aires–September 12 to 17, 1960

Unofficial Translation Supplied by George Browne, Editor, *Ingenieria Internacional Industria*

Resolutions:

1

Whereas:

1. Modern engineering demands from day to day the study and solution of inceasingly important problems, thus requiring broader and sounder training in mathematics, physics, chemistry and the humanities;

2. There is unanimous agreement that in the majority of the UPADI countries secondary school graduates are not adequately prepared for the study of engineering;

3. The deficient preparation of students starting their engineering studies is detrimental to the raising of their academic level;

4. Regional characteristics are very different both in general preparation and in technical requirements;

5. It is essential that anyone possessing the necessary knowledge and ability be able to study engineering irrespective of the type of secondary school he may have graduated from;

6. In the general interests of education secondary school courses should not be oriented exclusively toward preparation for any special university career,

It is recommended:

1. That, independently of the need for improving the teaching of science in secondary schools and of attempting to develop the power of reasoning in students, consideration be given to the possibility of establishing an intermediate course for the purpose of achieving a uniform level of knowledge and supplementing preparation for entry into engineering;

2. That in all cases universities should adopt the necessary measures to make sure that students starting engineering studies have had adequate preparation.

2

Whereas:

Education is an integral problem within each country, which cannot be approached independently in any of its stages as lack of coordination between the various stages would result;

It is the mission of technical schools (intermediate level) to prepare technicians who will be auxiliary to and intermediary between the engineer and the workman;

In some countries there is a notorious lack and even total absence of technical schools (intermediate level),

It is recommended:

That UPADI member organizations and universities bring to the notice of the competent powers in their respective countries the following points:

1. The universities should be consulted when reforms are introduced into the secondary and technical schools, bearing in mind that the universities have a guiding mission to fulfill in education.

2. Teaching imparted in technical schools (intermediate level) should not detract from their purpose of orienting studies for the preparation of engineers.

3. The establishment of technical schools (intermediate level) should be encouraged.

3

Whereas:

There are probably advantages to be derived from psychotechnical examinations at adequate levels as an aid in vocational orientation,

It is recommended:

That UPADI appoint a committee of specialists in the field of psychotechnics and engineering education to prepare for consideration at the next Congress a report which should:

1. define the best qualifications in a candidate, and
2. propose the most skillful methods of estimating and assessing such qualifications for information purposes.

4

It is recommended:

1. That universities disseminate among students in secondary schools aspiring to study engineering, and their parents, information on vocational conditions and opportunities for:

a. studying engineering and its various specialties,
b. practicing engineering as a profession, and

Points out

2. The possibility that candidates for admission to courses should take vocational tests and examinations, the results of which will be used in an advisory capacity and shall not be a motive for refusing admission.

5

It is recommended:

1. That UPADI:

1. Undertake the compilation of regulations, curricula, organization systems, statutes, statistical and other data on requirements for admission and origin of candidates of all the institutions devoted to the teaching of engineering in the Americas in order that they may be consulted by interested parties at the UPADI headquarters;
2. Undertake, in progressive stages, a comparative study of the data compiled in order to determine the proper place and function of engineering education in the universities of the Americas and submit it to the Second Congress on Engineering education;
3. Sponsor the exchange of teaching personnel among the different educational centers of its member countries to make known the various systems of education.

2. That engineering educational institutions at the university level consider:

1. That the study of the basic sciences (Mathematics, Physics and Chemistry) and of the sciences applied to engineering constitutes the basis of the engineer's training, and recommends that greater emphasis be placed on their teaching;
2. That, above all, teaching should endeavor to form an engineer's judgment to enable him constantly to perfect his knowledge, be qualified to study new problems and solve them creatively;
3. That the study of the humanities be intensified so that future engineers may secure an adequate cultural education and develop and encourage their interest in such subjects;
4. That the study of at least one foreign language be established in the most complete manner possible, and that the language be chosen on the basis of its usefulness in connection with the richest bibliographic material available;
5. That curricula should not remain static but evolve in accordance with the progress of science and the particular needs and conditions of each region; furthermore, that curricula be flexible to permit the introduction of optional subjects;
6. That practical professional training be established or intensified during the course of study or upon termination so that, upon graduation, new professionals may have had the greatest possible contact with the environment in which they will be called upon to carry out their activities;
7. That studies in organization, administration and economics be developed according to the needs of each specialty and the sphere in

which the professionals will expect to work;

8. That in the training of engineers their studies should put them in touch with actual conditions in their country;

9. That an endeavor be made, as far as possible, to establish a teaching system whereby students will actively participate in classes, avoiding if possible the passive type of class, thus leading the student to greater research work;

10. That in drawing up plans and programs engineering educational institutions devote special attention to a study and evaluation of the total weekly time the student should give to studies in order to comply satisfactorily with the demands made upon him;

11. That at a future Congress the extraordinary importance of the basic technical and engineering sciences in contemporary knowledge be analysed in order that they may be assigned the important position in culture which is due them.

6

Whereas:

Applied mathematics is of fundamental importance for the development of future engineers; and with the electives now offered in numerical and graphical analysis and later in mathematics applied to problems which occur in practice, it is indispensable to provide mathematical tools which are not now offered in standard courses; and the science of the application of mathematics in engineering must not be restricted to the simple but important level of teaching but should be applied to problems which present themselves in engineering practice as well as those submitted by industries for solutions;

This will be possible only as long as we have the mathematical tools and the students of mathematics who are able to analyze and solve these problems on a high mathematical level;

It is necessary for countries to form engineers with independence of thought who are able to formulate problems and to solve them applying suitable mathematical tools as well as the other sciences;

It is recommended:

That a laboratory of applied mathematics be established in every School of Engineering for the purpose of:

1. Organizing courses on numerical and graphical calculus and other mathematical tools having direct and acknowledged application in the specialties of engineering with the equipment, library and adequate teaching staff required;

2. Studying problems presented by students and professors of the departments of engineering and by industry; and publishing the results obtained whenever possible and advisable;

3. Establishing contact with important laboratories and carrying out scientific research work in the field of applied mathematics, publishing the findings, preferably in the corresponding school review; organizing seminars and publishing monographs on problems of direct technical interest.

7

It is recommended:

That the Permanent Commission on Engineering Education of UPADI undertake an exhaustive study of the paper presented to the First Pan-American Congress on Engineering Education by the Municipal School of Engineering of Mexico City and ask the universities in the Americas to give their opinion on the possibility and advisability of establishing courses on "Town and Integral Ecological Planning" as a discipline in their respective schools.

8

Whereas:

Engineering is a basic factor in technical and economic development,

It is recommended:

1. That UPADI, through its members in the various countries, promote a substantial increase in the funds designated for engineering educational institutions and a general improvement in such teaching facilities as laboratories, workshops, etc., as the only means of improving the

number and quality of the technical people in each country.

2. That UPADI urge its members to cooperate fully with engineering educational institutions so as to establish the necessary continuity between training and the application of techniques.

3. That UPADI encourage, and even organize, the exchange of professors among engineering educational institutions for the purpose of taking the fullest advantage of the outstanding experience in each country in the different technological and teaching systems and methods.

4. That the exchange of professors and students be promoted in order to contribute to the improvement of curricula in the different countries.

5. That UPADI undertake a study of the comparative merits of courses in the different countries in order to facilitate revalidation and confirmation of degrees.

9

It is recommended:

That UPADI urge research and graduate centers to develop activities which effectively meet the needs of progress in their communities.

10

It is recommended:

That the paper on "Organization of the training of mechanical and electrical engineers at the National Polytechnic Institute," presented by Ing. Manuel Marín González (Mexico) be forwarded to UPADI in order that the Permanent Commission on Engineering Education may bring it to the attention of the Schools of Engineering in the Americas.

11

It is recommended:

That Productivity Centers be established at Schools of Engineering for the purpose of holding courses for engineers and technicians in industry on specialization in methods and organization which are necessary to increase industrial productivity. This activity will also enrich the regular courses of the Schools of Engineering by virtue of the examples collected and the interchange established with local companies, affording students the opportunity of practical experience and of future employment.

12

Whereas:

Latin American countries are for the most part underdeveloped with an explosive rate of population growth;

Rapid industrialization of the Latin American countries is essential for the purpose of developing those countries and raising the living standards of their citizens;

An adequate number of sufficiently qualified engineers is necessary to carry out this purpose,

It is recommended:

That the following resolution be submitted to the Permanent Commission on Engineering Education for subsequent study:

1. That Latin American governments be urged to encourage the establishment of polytechnic and technological schools of higher education devoted exclusively to the training of engineers as a means of promoting industrialization.

2. That Latin American governments substantially increase the budgets of existing Schools of Engineering in order that they may render greater service to the community.

13

It is recommended:

1. That the American Society for Engineering Education be requested to have a translation into Spanish made of the publication "Evaluation of Engineers' Education" (1955) for distribution among the universities and professional associations of Latin America.

2. That a standing committee of UPADI be appointed to study the best way to establish or promote a closer relationship between the Schools of Engineering and industry in the Latin American countries.

3. That the members of UPADI in each country increase graduate studies for the training of engineers and research workers at the highest level to meet the needs of industry and education, and that the various ways of doing this be

studied for eventual recommendation to the Latin American countries.

4. That they promote higher education with emphasis on independent judgment and creative work especially during the last years of study and post-graduate courses for the purpose of training engineers at the highest level who will be capable of meeting the growing needs of industry and education.

That the various forms of post-graduate courses be studied in order to find those best suited to serve the needs of engineering in the Americas.

5. That engineering educational institutions hold practical classes in statistical mathematics which will lead later to the teaching of the concepts of this discipline and their application to engineering.

6. That the Schools of Engineering not neglect in their research programs those connected with specific problems relating to national development.

7. That, whereas:

a. A rapid development in engineering and its basic and applied sciences is going on at the present time;

b. Engineers being trained at present by the universities will practice their profession in the coming years; and

c. The only way of keeping informed on developments in a science or technology is to keep active in the research being carried out in the field,

It is recommended

(1) That research and teaching be centered in engineering educational institutions.

(2) That the number of full-time professors be increased to achieve a greater development of research work in such centers.

(3) That the time devoted exclusively to teaching be limited so that it will not interfere with research work.

(4) That the Permanent Commission on Engineering Education undertake the preparation of a dictionary of technical terms in the different languages spoken in the Americas.

14

It is recommended:

1. That a Standing Committee be set up in Buenos Aires, composed of a President, two Vice-Presidents, two Secretaries and five members, to be appointed by UPADI, which will be responsible for carrying out a study of the most suitable locations for regional scientific and technological research centers, and propose a method of financing them;

2. That this committee take the appropriate steps to obtain the necessary funds to have a full-time paid Executive Secretary in charge of the work connected with evaluating the possibilities and needs in this field;

3. That with this information the committee prepare a report on the work carried out and a definite working plan on regional research centers for the VII UPADI Convention;

4. That the Standing Committee likewise be authorized to request the cooperation of other institutions which may contribute information for the said study.

15

Whereas:

One of the objectives of UPADI is to encourage the international exchange of teachers, research workers, lecturers, professionals and students in the field of engineering, and it is evident that such international exchanges advance knowledge and further understanding among persons, institutions and countries,

It is recommended:

1. That UPADI urge the creation of an international center for the dissemination of information on such exchanges through arrangements with such international associations as the Organization of American States, UNESCO and the Latin American University Union.

2. That the UPADI members recommend to their governments that they become members of the International Association for the Exchange of Students for Technical Experience (IAESTE), as previously expressed in Resolution 42 of the V UPADI Convention, and that the necessary national committees be formed

so as to implement exchanges under this program.

3. That industrial concerns in the UPADI countries be encouraged to inaugurate or expand exchange arrangements with selected universities and training centers under which students are sent abroad for education and training directed toward subsequent employment with the company at home or abroad, and

4. That UPADI urge the establishment of engineering manpower and education surveys and consolidate all information available on the status and needs of engineers in each UPADI country to provide a frame of reference for the exchange of students, professors and engineers. For this purpose it is recommended that the plan of the EUSEC report be followed.

16

It is recommended:

That UPADI urge governments and engineering educational institutions to encourage basic and applied research to the maximum extent of their possibilities, guaranteeing as far as possible freedom in the choice of subjects for research.

With regard to the development programs, that engineering educational institutions endeavor to cooperate with other institutions in important problems of national development without thereby detracting from the fundamental activity mentioned above.

That engineers most qualified to find appropriate solutions to the technical and industrial development problems in each country with a spirit of innovation and efficiency will be precisely those who have had a sound education in the basic sciences which constitute the foundation of the various branches of engineering and training in research methods.

17

It is recommended:

1. That UPADI urge governments, universities and industry to give financial support to the Schools of Engineering to enable them to install and maintain properly equipped training and research laboratories. Only those Schools of Engineering having such laboratories where the teaching is imbued with a spirit of innovation and research, and where original work is carried out, will produce the engineers which modern society needs for continued technological and industrial progress and, consequently, guarantee the economic power and general welfare of their peoples;

2. That, with the object of helping to encourage research in the various fields of engineering, UPADI recommend that National Scientific and Technical Research Councils be established in all countries of the Americas where such an agency is not already in existence, that sufficient funds be assigned to them and that their autonomy be guaranteed. Such Councils shall have the following aims:

a. To encourage the training of new research workers;

b. To assist research workers who are employed in research institutions;

c. To promote on a world scale the exchange between scientific and technical research institutions.

3. That, for the purpose of encouraging professors of the Schools of Engineering and of attracting highly talented young people to the profession of teaching, it is essential:

a. That professors and research workers be guaranteed complete stability in their positions;

b. That the compensation of full-time professors and research workers be adequate to the importance of their function and that they be guaranteed

(1) a fitting standard of living;

(2) security in economic contingencies (family allowances, cost-of-living allowances, housing facilities, medical insurance, retirement benefits, etc.);

(3) the possibility of perfecting their knowledge (purchase of bibliographic materials, travel for the purpose of study, etc.)

Lack of the foregoing is producing an exodus of brilliant technicians and scientists in many Latin American countries which constitutes an

irreparable loss for their development programs.

c. That participation in congresses, symposia, etc. be facilitated, and the sabbattical year be effectively implemented, so that professors and research workers may spend one year out of every seven in scientific and technical institutions of the more developed countries.

18

It is recommended:

That in the agenda of the next Congress on Engineering Education UPADI give preference to the inclusion of the following points:

1. Social function of the engineer;
2. Scope and adequate length of engineering studies;
3. Balance between different groups of related subjects in the engineering curricula, and
4. Branches of engineering which it is considered should be divided into separate curricula, determination of their different fields and studies common to all of them.

19

Whereas:

The School of Engineering of the University of Buenos Aires has made a valuable contribution in publishing, through its library, a bibliography on engineering education which has been found extremely useful,

It is recommended:

That the School be asked to publish an annual selected international bibliography on engineering education consisting of:

1. Papers, articles, lectures, results of congresses and meetings relating to the subject;
2. Pertinent periodical publications;
3. Information on the organization, structure, operation and curricula of engineering education.

Furthermore, it is recommended that UPADI members and the institutions connected with them send to the library of the School of Engineering of the University of Buenos Aires any publications on the above subjects.

20

It is recommended:

That, in order to make the fullest use of the work of this Congress, all papers presented be published in full and, in the event that this is impossible for financial reasons, a selection be made with particular reference to the recommendations of the different Commissions and to the scope and general applicability of the subjects involved.

21

Whereas:

The representative of the students of the School of Engineering of the State of Rio de Janeiro made a proposal that student organizations be invited to future congresses,

It is recommended:

That the above proposal be submitted to UPADI with a favorable vote.

22

The First Pan-American Congress on Engineering Education resolves:

To express its appreciation to UPADI for having sponsored and organized the Congress which has made it possible to initiate an effective exchange of ideas on "Engineering Education" in the Americas.

Admission Requirements to Engineering Curricula in the United States

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and

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I. Structure of Educational Organizations in the United States

As a preamble to any discussion on engineering education in the United States of America, it must be clearly understood that there is no office corresponding to the Ministry of Education as in most other countries of the world, including the various Pan-American nations. Uniformity in admission standards, curricula, and student testing are arranged by voluntary cooperation through professional societies and other organizations. The tenth amendment to the United States Constitution leaves to the several states the right and responsibility to control and organize their educational systems as they deem most appropriate. In most states there is a State Department of Education or equivalent, which has supervision over the secondary and elementary schools and specifies certain requirements for graduation from the secondary school. However, within each state there may be considerable variation from county to county and from urban to rural areas on the qualifications for teachers and even the requirements for graduation from secondary school.

With one or two exceptions (the State of New York is one) there is no general control over institutions of higher learning even though most states have one or more tax-supported institutions of higher learning. There is usually no central control over the academic requirements even within the state. The state usually delegates this authority to an operating agency, which is variously designated as a Board of Control, Board of Trustees, or Board of Regents.

In addition to the state tax-supported institutions of higher learning, there are other publicly supported institutions receiving their funds from governmental units such as towns, cities and, in one case, the Federal Government in the District of Columbia.

Parallel to the tax-supported institutions of higher learning there is a system of education in the United States consisting of private institutions, which are supported by non-government funds. Many of these institutions received their original impetus and support from various religious organizations. The religious organization's funds are in most cases supplemented by gifts and grants from other sources. Not all of the privately supported institutions, however, have religious support. The privately supported institutions depend for their existence, in addition to tuition of the students, on gifts and grants from individuals, foundations, and corporations.

In general, each institution of higher learning, whether tax-supported or non tax-supported, sets its own admission re-

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quirements, curriculum and graduation requirements. Since there is no national accrediting agency or even state accrediting agency, certain voluntary regional groups have assumed the accreditation function. In addition, the various professional societies have established criteria for accreditation of those institutions of higher learning which meet the standards of a particular profession. In the engineering profession, the accrediting program has been delegated by the various professional societies to the Engineers' Council for Professional Development.

This paper deals only with the admission requirements to the institutions of higher learning having engineering approved by the Engineers' Council for Professional Development. The various curricula and graduation requirements as well as other items will be discussed by others at this Congress. However, it is obvious that the admission requirements must bear some relation to the curricula, since those institutions which admit poorly prepared students could not compete curriculum-wise with those institutions which hold higher admission standards. The American Society for Engineering Education is the member society of the Engineers' Council for Professional Development which has direct responsibility for engineering education. In 1951 all of the engineering societies which are members of the ECPD requested the American Society for Engineering Education to make a study of the engineering curricula with the purpose of establishing criteria for accreditation purposes. The ASEE Committee on Evaluation of Engineering Education worked on this subject for three years, 1952–55, and published its final report in 1955.[1] This study had an immediate impact on the admission requirements in various institutions of higher learning both tax- and non-tax supported. It became obvious from this report that the two major weaknesses in the admission requirements were:

a. permitting students to enter institutions of higher learning to study engineering with insufficient background in mathematics, and

b. allowing entrance with a weakness in the communication skills of reading, writing, and speaking of the English language.

The impact of this report, the follow-up report on the engineering sciences and the study on the humanistic-social stem will be discussed separately before this Congress.[2]

The raising of the requirements for admission to the engineering colleges proceeded rapidly after 1955 and the change was accelerated after October 4, 1957, when the U.S.S.R. successfully launched its first earth satellite, Sputnik No. 1. In fact, the change in admission requirements was verified this year by a questionnaire to each of the ECPD-accredited engineering institutions. There are 154 institutions which have one or more of their engineering curricula accredited by ECPD. There are 77 other institutions of higher learning in the United States which offer degrees in engineering. However, in 1958–59, 88% of the engineering first degrees were conferred by the ECPD accredited institutions and 84% of the total registration of students studying engineering were enrolled at ECPD accredited institutions, according to figures compiled by the United States Office of Education.[3] The data in this paper were confined to the 152 ECPD-accredited institutions which admit students to first year programs of study. It is thus believed that with these data and the confirmation from the answers to the questionnaire, the information given below is currently reliable.

In order that there will be no confusion on definitions and words, the same nomenclature will be used throughout this paper as that which was adopted by

[1] Report of the Committee on Evaluation of Engineering Education, June 15, 1955, published by American Society for Engineering Education, Urbana, Illinois.

[2] F. C. Lindvall's "The Engineering Curriculum."

[3] Wayne E. Tolliver and Henry H. Armsby, "Engineering Enrollments and Degrees in ECPD Accredited Institutions, 1959," JOURNAL OF ENGINEERING EDUCATION, Vol. 50 (1960), page 450.

TABLE I

TABULATION OF SECONDARY SCHOOL PROGRAM OF STUDY REQUIRED OR RECOMMENDED BY ECPD ACCREDITED INSTITUTIONS OF ENGINEERING IN THE UNITED STATES

		a	b	c	d	e	f	g
Number of Institutions		98	47	3	2	2	2	154
	Course Title	Units*	Units	Units	Units			
Program of Study	English	4	3	3 or less	N. S.	Do not admit first-year students	Did not report	Total no. of institutions
	Mathematics	4	4	3 or less	N. S.			
	Science	2	2	N. S.**	N. S.			
	History	1	1	N. S.	N. S.			
	Language (other than English)	2	2	N. S.	N. S.			

* A unit represents the study of a subject a full school year with recitations four or five times a week or the equivalent for periods from 45 to 60 minutes each, and requiring outside preparation for each recitation period.

** N. S.—No specific requirements or recommendations stated.

the EUSEC Conference held in Paris, France, September 16–20, 1957.[4]

As noted above the specific admission requirements for each college of engineering is the function of that institution. However, essentially there are two major requirements generally observed.

1. The student must graduate from an accredited secondary school with grades and subject matter satisfactory to the college, although in special cases exceptions are made. Many believe that the position of the student in his high school class is one of the better indications of ability to do well in institutions of higher learning.

2. Most institutions require some additional test scores such as the College Entrance Examination Board (CEEB) [5] or tests devised by the individual institutions.

3. Many non-tax supported institutions, also, require a personal interview.

[4] *Proceedings of the Third EUSEC Conference*, September, 1957. Published by the Engineers' Council for Professional Development, U. S. A., 29 West 39th Street, New York 18, N. Y.

[5] College Entrance Examination Board, 475 Riverside Drive, New York 27, N. Y.

II. Common Admissions Requirements

The questionnaires mentioned previously were sent to 154 ECPD accredited engineering institutions of higher learning. Usable data were obtained from 150 institutions, two did not return reports concerning their programs and two others did not admit students to first-year study. Answers from these 150 institutions expressed requirements or made recommendations that imposed on the entering student preparation in basic course areas that were common to all. Table I, columns (a) and (b) indicate that except for the amount of English required, 145 out of the 150 institutions admit students with a common subject matter preparation in mathematics, science, history and language. The five institutions in columns (c) and (d) of Table I were the exceptions. The results of this study reveal a marked increase in subject-matter requirements over that practiced in the "pre-Sputnik" era on the basis of data revealed in the EUSEC report previously referred to in this paper.

The secondary school mathematics program usually consists of two years of algebra, one year of plane geometry, one-

half year of trigonometry, and one-half year of solid geometry. Many secondary schools are in the process of presenting a unified program of mathematics as suggested by the Commission on the Study of Mathematics in its 1959 report rather than the present segmented approach.

The laboratory science programs of study normally consist of one year of chemistry and one year of physics. Some institutions will accept one year of biology instead of either chemistry or physics. These amounts of English, science, and mathematics are considered minimum amounts. Many institutions encourage students to take additional courses in both science and mathematics.

The entering student is usually required to take an examination prior to being given consideration for admission. Most privately supported institutions require the results of the Scholastic Aptitude Test of the College Entrance Examination Board, which is a corporation chartered under the University of the State of New York, Education Department, for the purpose of serving educational organizations. It serves in connection with (a) the transition of students from secondary schools to colleges and other institutions of higher learning and (b) in the coordination of secondary schools and higher educational activities relating to the identification and evaluation of student capacities, (c) the admission of students and (d) their educational guidance. The CEEB provides and administers a series of standardized examinations, the results of which are widely used by institutions of higher learning to determine aptitude and achievement in various subject matter areas as a part of the admissions process. Most commonly used tests of the CEEB are the Scholastic Aptitude Test (SAT), the Achievement Tests, and the Advanced Placement Examinations. The SAT is a three-hour examination that evaluates the extent of development in mathematical and verbal abilities. About one-half of the colleges require, in addition to the SAT, three Achievement Tests. Some colleges specify which tests the applicant must take although most allow the student some choice. Achievement in English composition is tested by almost every college requiring achievement examinations and about one-half of those require the results in mathematics and either physics or chemistry. At present there are thirteen one-half hour long Achievement Tests in the subject matter areas of: English composition, mathematics, social studies, French, German, Spanish, Italian, Latin, Greek, biology, chemistry and physics. The Achievement Tests measure not only the student's understanding of the subject matter, but, also, his ability to reason and solve problems within the area tested. Each test covers a broad range of topics within the subject matter area tested. The Achievement Tests are given four times a year (in December, March, May, and August) in the afternoon of days when the SAT is administered. In addition, provisions are made for the SAT to be given each January, February and March. The examinations are given in almost every geographic location in the United States and in most countries of the world. Argentina, Bolivia, Brazil, Canada, Chile, Columbia, Cuba, Dominican Republic, Ecuador, Guatemala and Peru have established testing centers.

III. Variation in Admissions Requirements

A number of engineering colleges operating as part of a tax-supported university do not admit students directly into the engineering divisions. These universities divide the study program into (a) the general college and (b) the various professional colleges. A grade level commensurate with average or better work in the courses undertaken in the general college over a period of one year or more is considered as adequate evidence of academic ability.

Sixty institutions make provision to accept students with subject matter deficiencies. In every case remedial work is required. Usually the student must extend the period of time required to complete his engineering studies in order to overcome the deficiency. Deficiencies may be due either to the fact that the student did not take the subject matter in the secondary school or to failure in tests given at the institution of higher learning.

TABLE II

SURVEY OF ADMISSIONS CRITERIA FOR FIRST TERM STUDENTS IN ENGINEERING CURRICULA OF THE COLLEGES IN THE UNITED STATES APPROVED BY THE ENGINEERS' COUNCIL FOR PROFESSIONAL DEVELOPMENT

	Yes	No
1. High school graduation is required	136*	14
2. Favorable recommendation from the high school is required	116	34
3. Fifteen or more units of credit are required	138	12
4. Credit is allowed for vocational subjects	93	57
5. An entrance examination is required	123	27
a. C.E.E.B.—Scholastic Aptitude Test is required	96	
b. C.E.E.B.—Achievement Test is required	78	
6. First-year students are admitted to college-level courses with advanced standing	120	30
7. Students are admitted with subject matter deficiencies	60	90
a. If admitted, are they required to pursue a remedial course	60	

* In addition, position in the high school class is weighed.

Practice work or the study of vocational subjects is not a requirement for admission to engineering study. Table II, item (4) indicates that almost two-thirds of the institutions allow some credit for vocational subject matter study in the high school. Only sixteen of the institutions make any reference to vocational subject work such as mechanical drawing or shop.

Every institution tests its students as part of the admissions or matriculative process. If aptitude or achievement tests are not required as part of the admissions process, the usual pattern is to subject the new student to testing for placement and/or counseling purposes. Diagnostic and prognostic testing and sometimes psychological testing of the newly matriculated student take place during his first week or two on the campus.

Advanced placement programs exist in 80% of the ECPD accredited institutions (see Table II, item 6). These programs permit the able and ambitious students, while still in the secondary school, to undertake work on the college level commensurate with their abilities.

Two forms of the program are extant. One is administered by the institution itself with the testing and evaluation of the student for advanced placement being accomplished in its entirety by the institutions concerned.

A second form of the advanced placement program is accomplished by the CEEB Educational Testing Service in cooperation with the secondary schools and the institutions of higher learning. The CEEB provides a syllabus and tests in thirteen subject matter courses including: literature and English composition, American history, European history, French, German, Latin, mathematics, biology, chemistry, and physics. Examinations are prepared in each course by committees of five teachers, three from institutions of higher learning and two from secondary schools. The examinations are based on college-level courses. Other committees consisting of readers qualified in the course evaluate the examinations. The materials supporting a student's request for advanced placement are sent to the institution of his choice by the CEEB. These materials include a secondary school report, which gives a description of the course taken, course grades, and the school recommendation. The institution of higher learning, also, receives the Advanced Placement Examination report from CEEB, which includes a copy of the examination questions, the student's paper and the grade assigned by the reader. The institution concerned makes its own decision regarding advanced placement.

Secondary school students seldom take college-level courses in more than one or two of the subjects offered. Very few, therefore, can hope to finish their engineering study programs any earlier than usual. They enrich rather than accelerate their studies.

The program is expanding.[6] Its growth is the result of studies in the early 1950's supported financially by the Fund for the Advancement of Education. Students

[6] College Entrance Examination Board, "A Guide to the Advanced Placement Program of 1959–60."

taking the examinations have increased in number from 532 in 1953–54 to 5,862 in 1958–59.

IV. Evolving Pattern of Pre-Engineering Study

There are several comments that should be made concerning the evolving pattern in admissions qualifications.

1. Students are presenting for admission more mathematics, English and science than most institutions require. Consequently, students who barely meet subject matter entrance requirements find themselves in serious difficulty because of the competition from better prepared students.

2. The quality of instruction in science and mathematics in the secondary school is improving. Students are able to study mathematics and science at a more advanced level in the beginning year, thus allowing for the earlier introduction of professional and enrichment courses. Various programs sponsored by the National Science Foundation (NSF),[7] an independent agency of the United States Government with the primary function (1) to improve the quality of scientific education; (2) to enable promising youths to prepare for careers in science; (3) to provide financial support for basic research; and (4) to foster more widespread understanding of science and a congenial environment for creative scientific scholars; have spear-headed the improvement of science instruction by making it possible for teachers in secondary schools and colleges to obtain additional knowledge of subject matter and to become better acquainted with new developments in science and mathematics. Four types of major institute programs are supported by the Foundation: (1) summer institutes for high school teachers of science and mathematics, (2) summer conferences for college teachers, (3) academic year institutes for high school and college teachers, and (4) in-service institutes for high school teachers.

[7] National Science Foundation, 9th Annual Report, 1959, Superintendent of Documents, U. S. Government Printing Office, Washington, D. C.

The Summer Institutes program started in 1953 with 100 participants. In 1959 more than 21,000 teachers participated, 20,000 of whom received NSF stipends.

The Summer Conferences for college teachers are of four weeks' duration and provide facilities for an exchange of ideas among the participants and an opportunity to learn of recent subject material advances. A series of 20 conferences was held during the summer of 1959 for 546 college teachers.

Academic Year Institutes are full-time, year-long programs of study in science and mathematics designed especially for secondary school teachers in these fields. Financial support for the teacher and for the host institutions is provided by grant from the Foundation. The courses of study are planned by the sponsoring colleges and universities; each institution supplies the facilities and administers its own program. For the 1959–60 academic year, thirty-two colleges and universities were the recipients of awards to continue the programs. The Foundation grants are made to sponsoring institutions. They provide to the teacher undergoing instruction a maximum stipend of $3,000 per academic year, plus additional allowances for dependents, travel, and books. The institutions receive direct support for the operational cost so the teachers do not have to pay the usual tuition or fees.

The In-Service Institute Program offers opportunities to teachers from secondary schools for further study in the subject matter of sciences and mathematics during out-of-school hours in the academic year. Participating teachers receive no stipends, but are given a travel allowance at a maximum rate of 7¢ per mile for each trip from home to the Institute and return. The sponsoring institutions receive support for direct costs of operation. In 1959, 182 grants for in-service institutes were made to 162 different institutions in 40 states, the District of Columbia and Puerto Rico.

Special projects in science education sponsored by the National Science Foundation are, also, assisting in the development of a more adequate program of science and mathematics education. These projects are planned in cooperation with

universities, colleges, scientific societies, research organizations, and other groups to enlist interest in and to promote the understanding of science, mathematics, and engineering by students in the secondary schools. There are seven aspects to this program:

(1) Visiting scientists to secondary schools. Under this project, grants are made to professional societies for the administration of programs of visiting scientists to secondary schools to acquaint students and faculties with sciences as vital activities and to provide counsel concerning careers in education. The participating scientists receive travel expenses and may receive a modest honorarium not exceeding $50 per day of school visitation.

(2) Traveling high school science library program. This program makes available on a loan basis a carefully selected library of general interest books covering the broad spectrum of science fields.

(3) Traveling science demonstration lecture program. Selected teachers, trained in demonstrating scientific principles in the classroom, travel over designated areas of the country, visiting secondary schools upon request. Participating teachers receive salaries equal to their normal monthly salary for a 12-month period. In addition, all travel expenses are paid.

(4) Science clubs and student projects. This program is aimed particularly at pre-college age students providing support for extra-curricular science projects under the guidance of national youth organizations.

(5) Summer training for secondary school students. This series of projects provides grants to colleges, universities, and other non-profit research institutions to enable them to offer opportunities to unusually able secondary school students to study and work during the summer with experienced scientists and mathematicians at the sponsoring institutions. About 6,000 students participated in this program during the summer of 1959.

(6) State Academies of Science. State Academies of Science and similar organizations receive support to strengthen interest in science among young people.

(7) Science career information. Career guidance materials prepared by scientific organizations to give authoritative information to students considering professional careers in various fields of science are supported.

As a result, the quality of teaching is improving and we can expect a continual up-grading of entrance requirements.

V. Summary

Admissions programs of the engineering colleges of the United States are of two types: tax-supported institutions that must provide for the graduates of their constituency and, consequently, admit students with minimal requirements and then screen them through various devices prior to admission into the professional schools including engineering; and private institutions, which have more rigorous admission requirements and provide for the admission of those who give evidence of ability to undertake professional engineering study.

Each institution is responsible for establishing and enforcing its self-imposed standards. No governmental agency exists to enforce standards or prescribe programs of study. In order to produce graduates with a level of proficiency in keeping with that of other engineering institutions, each must so modify its program of study that its students are advanced from their academic level on entrance to the full professional stature of an engineer upon graduation. All of the efforts of the institutions to insure a common level of professional development among the graduates is a voluntary one. Various professional organizations such as the Engineers' Council for Professional Development and the American Society for Engineering Education assist in the coordination of efforts to insure the quality of graduates.

Through standards set by the Engineers' Council for Professional Development, the accredited institutions graduate at the bachelor's level neophyte engineers, who have reached a minimum proficiency. Obviously the graduates of

some institutions will excel in quality and breadth of information the graduates of some others. However, there are many who believe that the excellence of the graduates at the bachelor's level of certain institutions bears a stronger relationship to the screening of students at entrance than to a variation in presentation of subject matter at the different ECPD accredited colleges. There is good evidence to show that the top graduates of any ECPD accredited institution are able to perform well at any of the graduate schools.

The admission standards considered in this paper are far from infallible and the will to learn can often overcome poor preparation. Conversely, the lack of the will to learn is the most common cause of failure in even the well prepared student.

RESEARCH ON MANAGEMENT SCIENCE

A Research Institute for Management Science was established in 1952 on the instigation of the Technological University of Delft as a non-profit organization. The aim of "Research-Instituut Voor Bedrufswetenschappen" is to promote research, education, and training in fields of management science. A number of reports have been completed but "Review of Management Research" published in 1959 is of particular interest. The fifty-page report has a price of Dfl. 7.50 plus 5% for postage. Inquiries should be directed to RVB at 76, Nieuwe Laan, Delft, the Netherlands.

FELLOWSHIPS IN ADMINISTRATION OF HIGHER EDUCATION

The Center for the Study of Higher Education at the University of Michigan, with funds provided by the Carnegie Corporation of New York, has announced that additional fellowships will be available for the academic year 1961–62.

On a postdoctoral basis, five Michigan Fellowships in College Administration, will be granted to persons newly entered upon or planning to make college or university administration a career. The applicants must be under 40 years of age, have substantial academic records, and be recommended as having high potential for a career in administration. The doctorate may be from any academic or professional field. The stipends are intended to cover living and incidental expenses, subject to maximum grants of $8,000. The fellows devote the academic year to study, research, internships, and other experiences relevant to the administration of higher education.

A few fellowships, bearing a maximum stipend of $3,500, are also available to persons under 40 who do not possess a doctor's degree. Both postdoctoral and predoctoral programs permit study in either junior or senior college or university administration.

Applications should be presented on or before February 1, 1961. Requests for further information and for application forms should be addressed to Algo D. Henderson, Director, Center for the Study of Higher Education, University of Michigan, Ann Arbor, Michigan.

The Engineering Curriculum

FREDERICK C. LINDVALL

The objectives of an engineering school establish the nature of a curriculum; the faculty determines its quality; the students demonstrate its effectiveness. Thus there is an analogy to a work of engineering: an objective is to be achieved in the design; the materials and the skill of the designer establish the quality; the effectiveness and utility is demonstrated by those who use the resulting engineering device or system.

It is appropriate, then, to approach the study of an engineering curriculum in the way we approach an engineering problem. The principal steps are:

1. state the problem or the objectives,
2. state the boundary conditions,
3. design the solution,
4. test the solution against the objectives stated in the problem and estimate the significance of the assumptions, and
5. evaluate the over-all results.

The objectives of an engineering curriculum must first be identified with the part of the entire spectrum of engineering activity for which the education is intended. Engineering and engineers may be concerned with some aspects of basic or fundamental scientific research which has as its object the establishment of new fundamental laws and principles and the determination of new knowledge about nature. Engineers may be concerned with the other extreme of this technical spectrum where the interest lies in practical application, use and maintenance of devices and systems. Between these extremes lie the functions of *development, test, evaluation, production engineering, manufacturing,* and *marketing.* With all of these activities engineers are vitally concerned to a greater or lesser degree. Yet it is clear that an education which is best for one type of activity is not necessarily best for another. Marketing and application engineering will call for skills and knowledge quite different from those needed in research and development. Some engineering is what is called "state of the art engineering" in which well known principles, materials and practice are adapted to new applications. No new discovery or invention is needed but skillful design and utility and economy are required. For such work an education which emphasized design, application and current practice would be useful whereas this type of information and knowledge would be of much less value to an engineer concerned with advanced development and design at the frontiers of technical progress.

Another important feature in the practice of engineering is the amount and quality of supporting personnel available to assist the engineer. Such personnel are in large measure the products of the educational system of a country and the practising engineer will be able to work at a level determined by the knowledge and skills of his assistants. In the United States the general education has in the past produced too few technicians or engineering aides, with the result that many engineers have been engaged in work which did not require all of their professional education. These engineers, with suitable technician help, could have worked at a higher professional level. Alternatively, fewer engineering graduates would have been needed if they could have been adequately supported. Thus, comparisons of U. S. and European engineering education [1] should note the

Presented at the Pan-American Congress on Engineering Education, UPADI, Buenos Aires, September, 1960.

[1] Third EUSEC Conference on Engineering Education, Paris, 1957. Published by the Institution of Mechanical Engineers, London. See also U. S. A. Contribution to EUSEC Conference, Paris, 1957. Published by ECPD.

education of technicians as well as of the engineers themselves in order to understand the training needed for the full spectrum of engineering activity. It could be that in an educational system which provides technicians of high quality an objective of the education of the professional engineer would be to have a relatively small number of extremely well educated engineers.

Another objective of engineering education is to meet specific needs of the national economy, the government and the military. Highways, railways and communications may be major efforts required in the development of a country, and the educational system should provide an adequate supply of suitably trained technicians and engineers for such activity. Similarly, special natural resources, such as petroleum, might dictate emphasis on exploration, production and refining at various technical levels.

Engineering education which is broad and flexible is a quite different objective, probably best suited to older, well-developed economies. The objective is not immediate skill in a specialized field, but an education which will be very adaptable to any new technical situation. The education would be for tomorrow's problems, not today's. In the U.S.A. curricula exist which are broad and have long range objectives. Many others exist which are designed for immediate utility. In fact both types are present together in some of our large universities. In the U.S.S.R., by way of contrast, most of the curricula are narrowly specialized to meet immediate planned needs. However a few are of such breadth and scope to meet the objective of long-range flexibility or adaptability.

With its objectives clearly established a school may develop its curricula within the boundary conditions and limitations, internal and external. These factors will include:

The level of education and achievement which would admit a student to the engineering curricula—that is, the admission requirements in mathematics, physics, chemistry, language, history, social studies, shop practice, mechanical drawing.

A policy of the school on admission as a "whole man," that is with his nontechnical education in humanistic and social studies considered to be complete. This could be called professional education following a liberal education.

The time span of the curriculum.

Cooperative or "sandwich" programs.

Education "on the job" after the diploma, which reduces the amount of applied engineering instruction in the curriculum.

The probability of work toward advanced degrees by a substantial fraction of the students.

External control of ministry of education type.

Policy on student advancement of average or poor student.

Policy for full development of superior student.

Accommodation to military training requirements.

A curriculum may then be developed within these internal and external constraints leading toward the several aims which define the objectives of the school. This curriculum is an expression of the faculty, its interests and talents. For all schools and all faculties no one curriculum may be prescribed. It is necessary to make some assumptions in order to confine the problem. This I will now proceed to do.

These assumptions are: students enter with mathematical competence in advanced algebra and trigonometry; students will have had some chemistry and physics. It is further assumed that the entering students have had some mechanical drawing and shop practice because these are subjects which can be learned in preparatory school or "high school" in the U. S. meaning of this level of secondary education. Also we assume that the entering students have had some study in foreign language, writing in the native language, history and social science subjects but not enough for a professional education. These assumptions define or describe a typical student who enters one of our better U. S. engineering colleges. He possibly would not have had drawing or shop practice and would thus

be required to crowd these subjects into his engineering curriculum, or to do the work in a summer session. This typical student will be about 18 years of age, or 20 to 21 if he has done military service before beginning college. He will have had at least 12 years of elementary and secondary school education. He will have had no engineering experience, except under unusual circumstances or possibly in a minor way through hobbies or a high school science project.

With such preparation a student is able to begin analytic geometry and calculus and chemistry in his first year of the engineering curriculum. He may also begin physics in this first year. Sample curricula are reproduced here to show three types of programs in one specialty. Electrical Engineering is chosen as an example. Other curricula, such as Mechanical, Civil, Chemical, Aeronautical Engineering and so on, have similar patterns. One which is quite typical of U. S. engineering education is curriculum A. At least three fourths of U. S. engineering students follow such a sequence, differing in detail in specific courses applying to the particular specialty.

CURRICULUM A

CURRICULUM IN ELECTRICAL ENGINEERING

First Year	
First Semester	Credit Hours
General Chemistry	3 or 4
Engineering Lectures	0
Engineering Graphical Communication	3
Analytic Geometry	5
Rhetoric and Composition	3
Physical Education	1
Military	1
Second Semester	
Chemistry of Metallic Elements	4
Engineering Geometry	3
Calculus	3
General Physics (Mechanics)	4
Rhetoric and Composition	3
Physical Education	1
Military	1
Second Year	
First Semester	
Calculus	5
General Physics (Heat, Electricity, & Magnetism)	4
Principles of Effective Speaking	3
Analytical Mechanics (Statics and Dynamics)	4
Physical Education	1
Military	1
Second Semester	
Elements of Economics	3
Electric Circuits & Fields	4
Differential Equations & Orthogonal Functions	3
General Physics (Sound, Light, & Modern Physics)	4
Technical Electives, or Social Science or Humanities Electives	3
Physical Education	1
Military	1

Third Year	
First Semester	Credit Hours
Electric & Magnetic Fields	3
Introduction to Circuit Analysis	4
Circuit Laboratory	1
Thermodynamics	3
Electron Properties of Solids	3
Technical Electives, or Social Sciences or Humanities Electives	3
Second Semester	
Circuit Analysis	4
Circuit Laboratory	1
Magnetic Circuits and Transformers	3
Magnetic Circuits Laboratory	1
Electronics	4
Transmission Lines	3
Social Science or Humanities Electives	3
Fourth Year	
First Semester	
Electrical Machinery	3
Electrical Machinery Laboratory	1
Advanced Electronics	4
Elementary Mechanics of Deformable Bodies, or Electives	3
Electives	5
Social Science or Humanities Electives	3
Second Semester	
Economics Aspects of Engineering	3
Electives	9
Nontechnical Electives	5

A less typical but somewhat more advanced program is curriculum B.

CURRICULUM B

First Year	
First Semester	Credit Hours
General Chemistry	4
Physics	4
Calculus	3
Introduction to the Humanities	3
Elective subject	2
Second Semester	
General Chemistry	4
Physics	4
Calculus	3
Introduction to the Humanities	3
Elective subject	2

Second Year	
First Semester	
Applied Mechanics I	3
Introductory Circuit Theory	4
Physics	4
Calculus	3
Humanities	3
Second Semester	
Applied Mechanics II	3
Introductory Circuit Theory	4
Physics	4
Differential Equations	3
Humanities	3

Third Year	
First Semester	Credit Hours
Electronic Devices and Circuits	3
Fields, Energy and Forces	4
Advanced Calculus for Engineers	3
Humanities	3
Elective subject	3
Second Semester	
Electronic Circuits and Signals	3
Electromechanical Energy Conversion	4
Humanities	3
Elective subjects	6

Fourth Year	
First Semester	
Energy Transmission and Radiation	3
Molecular Engineering	4
Thesis	1
Humanities	3
Elective subjects	4
Second Semester	
Thesis	2
Humanities	3
Elective subjects or additional Thesis	10

A still further advanced curriculum which is designed primarily as preparation for graduate study is curriculum C.

CURRICULUM C

Courses run through first and second semesters.

First Year	Credit Hours
Calculus, Vector Algebra, Analytic Geometry	4
Physics—Mechanics, Heat, Sound	4
General Chemistry	4
English	2
History of European Civilization	2
Basic and Applied Graphics	1
Physical Education	1

Second Year	
Calculus, Vectors and Differential Equations	4
Physics—Electricity and Magnetism and Optics	4
History of the United States	2
Physical Education	1
Electives	5–7

Third Year	
English Literature	3
Applied Mathematics	4
Physical Education	1
Electives	8–10

Fourth Year	
Humanities Elective	3
U. S. Constitution	1
Engineering Conference and Presentation	1
Physical Education	1
Electives	10–13

Electives may be chosen widely from science and engineering courses in consultation with a faculty advisor to develop a basic engineering curriculum leading toward graduate work in a specialty which the student chooses. Among the electives must be a basic course in economics. This type of curriculum can be good education if all of the electives are substantial courses which are well integrated with each other and if a system of faculty advising and counseling is good enough to assure adequate breadth and at the same time sufficient concentration in one specialized area. Curriculum A supposes typical U. S. high school preparation. Curricula B and C assume more thorough preparation in mathematics so that the level of beginning college work is somewhat more advanced. B and C also assume a more thorough initial selection of able students. Curriculum A depends upon first year college courses to separate the "men from the boys" or to accomplish the selection of those students who have the aptitude and ambition to go on in the engineering curriculum.

These three curricula may have somewhat different objectives but all are based on certain fundamental criteria. The Engineers Council for Professional Development has adopted certain criteria based on studies by the American Society for Engineering Education. Reference should be made to "Evaluation of Engineering Education" an ASEE report of June 1955. The following criteria of ECPD are quoted from the 1959 Annual Report of ECPD.

"To assist in the identification and recognition for accreditation purposes of those curricula mentioned above, Council adopted Additional Criteria on October 14, 1955. These have proved helpful both to ECPD and to the engineering schools. However, experience has shown a tendency toward a rigidity of interpretation by schools much beyond that intended by ECPD. This revision aims to convey the intended meaning more accurately, especially concerning the engineering sciences. It is to be emphasized that ECPD desires to encourage new developments and experimentation, as well as to assist those desiring guidance in achieving good and acceptable standards.

The criteria below include statements concerning basic and engineering sciences. Basic sciences include mathematics, physics, and chemistry as well as such fields as geology and biology. In basic sciences the objective is the establishment of fundamental knowledge about nature and its phenomena, preferably including quantitative expression.

Engineering sciences have their roots in basic sciences, but carry knowledge further toward applicability. When a basic science proves pertinent to an engineering application, there develops a corresponding engineering science to bridge between the basic science and engineering. Engineering sciences delve into the more practical or engineering-type situations, illuminate these with logical reasoning based upon the fundamental laws and generic principles of basic sciences, and lead into the statement of and methods of solution for problems fundamental in engineering analysis, design and synthesis. Fuller discussion of basic and engineering sciences and their role in undergraduate engineering education will be found in reports of the American Society for Engineering Education.

1. An engineering curriculum acceptable to ECPD will normally be characterized by:

a. At least the equivalent of one academic year of basic sciences, about half of which is mathematics beyond trigonometry.

b. At least the equivalent of approximately one year of engineering sciences. These should provide breadth of coverage and should not be limited to those having apparent specific relevance to the major field. Also recognition should be given to the emergence of new engineering sciences. Because of the merging of boundaries between the basic and engineering sciences, greater significance is attached to the depth and breadth of coverage in, and to the total curricula attention to, both of these areas than to the precise division between them.

c. At least the equivalent of approximately one half of an academic year devoted to engineering analysis, design and engineering systems.

d. Design of the curriculum for an integrated sequential study in the scientific and engineering area, including both theory and the experimental method. Mathematics and basic sciences should be used effectively in the work in engineering analysis, in the study of engineering systems, and in the preparation for creative design.

e. Depending upon the definition of humanistic-social studies, the equivalent of one-half year to one full year as the minimum content in the area of humanistic-social studies. Of this content, at least one-half year should be selected from such fields as history, economics, government, literature, sociology, philosophy, psychology, or fine arts, and should not include such courses as accounting, industrial management, finance, personnel administration or ROTC.

2. The above specifications total less than the minimum period of four academic years required to achieve an integrated and well-rounded engineering curriculum. Thus additional time is available for the full implementation of the educational objectives of the individual institution in the areas listed in 1, a-e. The pressures on four-year engineering curricula for strengthening the scientific approach to engineering and the social-humanistic content make it necessary that neither inadequate admission requirements nor additional academic objectives be allowed to compromise the standards inherent in these criteria. The engineering student taking an additional program in a field such as business, law, education, and advanced military science, is in effect pursuing two curricula with separate and different professional requirements and objectives. A realistic view recognizes that such dual-purpose programs require more than the normal four academic years. If the curriculum contains courses other than those needed to achieve the objectives of Section 1, these may be used for part of the additional program. Practical experience indicates that the total of this portion should not exceed, except as an overload or time in addition to four years, the equivalent of one-sixth of one academic year.

3. These criteria have as their object the assurance of an adequate foundation in science, humanities, engineering science, and introduction to engineering method while providing sufficient flexibility in science requirements to accommodate curricula requiring special backgrounds, such as life science or earth science. They also provide substantial flexibility for expression of the institution's own individuality and ideals. They are regarded as a statement of principles to be applied with judgment in each case rather than with arbitrary rigidity. Finally, they are intended to encourage and stimulate but never to restrain the creative and imaginative.

4. In any case in which the Education and Accreditation Committee is persuaded that well-considered experimentation in engineering curricula is under way, it shall give sympathetic consideration to departures from the criteria of Section 1 and shall make appropriate recommendations to ECPD.

5. The committee continues to favor broad basic undergraduate programs in engineering which will prepare a student to take advantage of as many different opportunities as possible, and prefers to minimize the number of specially designated curricula to be considered for accreditation. The committee is prepared to examine for approval any curriculum that appears likely to satisfy its criteria for an undergraduate engineering curriculum. Curricula of a vocational or technical institute pattern cannot qualify, nor can curricula of so specialized a pattern as to provide an inadequate base for engineering of a professional level.

Based upon these and other more quantitative criteria ECPD has accredited 850 curricula at 156 schools. The distribution of curricula ranges from one curriculum at nine schools, five curricula at 27 schools, to 15 curricula at one school. The number of separately listed accredited curricula and options is 27. Civil Engineering as a curriculum is offered by 138 schools, Electrical Engineering by 137, Mechanical Engineering 133, and Chemical Engineering by 98 schools. Thus these four most popular curricula account for about 60% of all accredited

curricula. At the other extreme, 13 or nearly half of the separately named curricula account for only 4% of all of the accredited curricula. There is a real question about the specialized nature of these particular engineering curricula, which are offered by so few schools. With no substantial professional engineering group which they represent to aid in setting standards, the criteria for accreditation must be on the engineering content, science, mathematics, and humanities and not on the specialty. The specialty can only represent sound application of engineering fundamentals.

The most important feature of a good curriculum is that which "will prepare a student to take advantage of as many different opportunities as possible." This is in sharp contrast to highly specialized programs for training of "specialists" as is the pattern in the U.S.S.R. The U. S. engineering education is based on the philosophy expressed by Alfred North Whitehead, who stated that it is the business of the colleges to teach principles, not detailed applications. The principles are the sound basis upon which a student can build and develop future applications. Those details and those applications which are discussed in the college work should be only for the purpose of illustrating the principles involved, not for the applications and the details themselves which will soon become obsolete as technology advances.

The illustration of principles or the illumination of the basic and engineering sciences is best accomplished by student experience in solving of appropriate problems. Some lecture illustration is valuable but the real learning comes when the student is required to apply these principles to new situations which he has not seen before in his text book or in lectures. Furthermore, the examples or problems should aid in developing a numerical sense, a feeling for physical size, for order-of-magnitude judgments. Professor von Karman in discussing the general problems of transportation at various speeds asks the basic question—what is the limit to the speed of a wheeled vehicle? This turns out to be a problem in strength of materials, the bursting strength of a wheel under centrifugal force. A value of assumed ultimate strength of the wheel tread material will quickly illustrate the principles involved and give a feeling for the upper physical limit of speed. This type of problem, with numerical values, begins to teach something of engineering judgment.

Another example might be taken from jet propulsion. The mechanics of a solid propellant rocket are well understood principles and may be expressed in a few simple relationships among the weights of motor, pay-load and fuel, and of fuel properties. But until numerical values are used in definite examples an engineer lacks feeling for the relative importance of the several parameters, specific impulse being one which is particularly significant. Also until some rough estimates are made of combustion chamber pressure, wall thickness and weight, the rocket will lack engineering significance and be only an interesting mathematical exercise. Engineers must develop confidence and judgment through a feeling for size, weight and physical properties. These can come through the examples which are used to illustrate the underlying physical principles.

Such examples, well chosen, can present the problem "inside out" and "backwards" in its approach as well as in a straightforward manner. The examples also should force students to assume values for missing data and to choose among conflicting bits of given information. This also aids in forming judgment in that the solution to the problem can be given between limits, "bracketed" so to speak, in the sense that the result must be less than some value and not greater than some other value. In addition the student can test his solution for its range of validity based on the uncertainties represented by his assumed values of input. Then as a final remark on the merit of such problems it should be noted that some students can readily grasp a basic principle or generalization but need the sense of reality of specific numerical applications, while other students need to follow through a series of specific examples in order to develop a feeling for the power or generality of the basic principles. Good problems aid both types of students.

An additional comment should be made on an important characteristic of a good curriculum. The student should experience a feeling of development or growth through the successive years of his education. The several subjects he studies should be well organized and integrated so that work in mechanics, electricity, and analysis builds on the foundations laid in the basic sciences. The problems and examples advance the student in his development and at the same time develop a feeling of unity or common basis for the engineering sciences and the engineering approach to problems.

The curriculum has been compared in this paper with an engineering work. I may also draw on another engineering analogy. Characteristics of a good design are: symmetry, simplicity, and continuity. I have stressed the importance of balance or "symmetry" in the curriculum as among the sciences, the engineering sciences and the humanities. I have emphasized the importance of fundamentals, or principles on which sound engineering is based. This is the element of "simplicity" at the expense of transient details of current practice. And in this last paragraph I have pointed to the value of continuous development, growth and a feeling of achievement. This is the element of "continuity."

This leads to a culmination of academic engineering study. A student should have the experience of a comprehensive problem. In some countries this is called a diploma project or senior problem and is given much prominence and attention, although in the U. S. A. the general practice is to defer this work to industrial experience. Its purpose is to bring together material from a variety of fields of science and engineering to produce a design or study which has some element of creativity or synthesis. Too often engineering education places its emphasis on analysis and fact, while engineering practice demands creation, invention and synthesis expressed through design. Time in an engineering school permits only a limited amount of effort on a design project. Yet design is the distinguishing characteristic of engineering and a student should be encouraged in its expression. Of course, in a diploma project only a reasonable student performance can be expected, not the larger, detailed and creative effort of a mature engineer. Nonetheless, the student extends himself, his accomplishment is for him a major effort. His design or creation is new to him, if not in the more sophisticated world of technology, and represents a rewarding experience. He gains even more if the faculty and professional engineers together evaluate and criticize his work. This problem could then be the evaluation of the merits of the curriculum before the final test of years of performance in professional practice.

To summarize briefly, the curriculum of a particular school conforms to its educational objectives. These can emphasize professional practice or concentrate on the more advanced analysis and science needed for pioneer work in research and development. Or the objective can be basic education for further professional education in postgraduate schools. In any case, the qualifications of the faculty should match the objectives and the selection of the students must be consistent with the nature of the curriculum. In this way a balanced design of the curriculum may be achieved.

NUCLEAR ENGINEERING AND SCIENCE DEPARTMENT AT RENSSELAER

Rensselaer has announced the establishment of a new academic department devoted to graduate-level teaching nad research in nuclear engineering and science. Dr. Clayton O. Dohrenwend, Provost, said the department will be known as the Department of Nuclear Engineering and Science.

It will administer the expanding physical facilities of Rensselaer's present nuclear programs including the Linear Accelerator Research Laboratory and Subcritical Reactor Laboratory. These, with other facilities, will constitute the Rensselaer Nuclear Engineering and Science Center.

Graduate Programs and Research in Engineering Colleges in the United States of America

BENJAMIN RICHARD TEARE, JR.

Dean of the College of Engineering and Science, Carnegie Institute of Technology, and
President, American Society for Engineering Education, 1959–1960

It is a great honor to me to have been invited to participate in this Conference, and I welcome the opportunity to be here and to become better acquainted with my colleagues in other American countries. I hope that this occasion will mark an increased exchange of ideas among the nations represented here and the closer cooperation of all of our engineering colleges.

Graduate education in engineering in the United States means post first-degree education. It is a program of study that is pursued in a university, a college, or institute of technology after graduation with a bachelor's degree from an engineering curriculum of four or more academic years, which is to be discussed at this meeting by Dr. Lindvall. Admission to a graduate program is usually granted only to students of superior ability whose previous academic records have placed them in the highest fraction of their class. The minimum duration of graduate programs if undertaken on a full-time basis is one year leading to a master's degree, or three years leading to a doctorate. Graduate programs are offered by some, but not all, of the same institutions that have undergraduate programs. Most of the graduate teaching is done by professors who teach undergraduate courses, although the extent to which this is done varies from institution to institution. In general graduate education differs from undergraduate education in the level of subject matter, in the degree of maturity of the students, and in the independence of thinking required of them.

Graduate study and research are important components of engineering education in the United States. Moreover they are growing at an increasing rate in extent and in significance. In my discussion here I plan to tell first why graduate study is important to our national technology, to the individual who undertakes it, and to the engineering college which offers it; second, the patterns of graduate education that are evolving in my country; and finally, something of the problems that are arising. Research in our engineering colleges is so closely related to graduate study that it is natural to treat them together.

Why Graduate Study is Undertaken

The nature of engineering education in the United States, at both graduate and undergraduate levels, has been influenced greatly by the requirements of industry and has undergone an evolution of its own as the needs of industry have changed. From about 1830 when Rensselaer Polytechnic Institute, the first school of technology in America, began instruction, down to the turn of the century, the pace and character of engineering education were set by the rapid expansion of railroads, mining, steel, and later by the electrical industries. Engineering schools were established at the undergraduate level, and they multiplied rapidly. Their pressing purpose was to provide technical practitioners to carry the huge industrial enterprises forward. Their educational policy was naturally to teach such knowledge and technique as

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would render the graduates as practically useful as possible. The engineering work in which they participated, notwithstanding its great importance, was not as directly based upon science as it is today, for much of the work rested upon a knowledge of practice, trial-and-error procedures, and a great deal of common sense and engineering judgment. In that period of frontier development the watchwords were not efficiency, conservation, and refined quality but raw tonnage, larger size, more miles of track, and the like. Yet during this period, which lasted well beyond 1900, there were great engineering triumphs, important inventions, and other achievements by engineers that created new opportunities for an increasing number of graduates. Thus did technology develop, and with it engineering education. The pattern that evolved was almost entirely one of education at the undergraduate level, where it still is for the majority of present-day engineers.

However, the requirements of a maturing technology have changed as it has come to be more dependent upon physical science, and as physical science itself has moved forward. A better understanding of the principles of physics and chemistry, together with new discoveries in these fields, has led to new possibilities and new opportunities in engineering developments. More and more have engineering advances demanded a deeper understanding of science, and to a lesser and lesser extent has it been possible to produce new developments by sheer cleverness, everyday experience, and a modicum of scientific knowledge. A different kind of engineer was needed, one who had more profound understanding, more extensive scientific knowledge, and more highly cultivated analytical and creative powers.

The recognition of this need has led in part to the modifications of the undergraduate curriculum that are described elsewhere in this program, and especially has it led to the growth of graduate education. A four-year undergraduate curriculum is simply not adequate for the highest levels of the kind of education that is required in engineering, no matter how well it is conceived and implemented, any more than it would suffice for the profession of medicine. Industry seeks men who have had graduate study for positions of leadership in research, development, and design, especially for the newer, advanced areas where the problems are growing progressively more complex. And universities seek them for faculty posts, as Dean Everitt points out.

The students themselves undertake graduate work in order to obtain a suitable educational preparation for such positions; they are also motivated by the challenge of higher goals, by love of more learning, and by the greater remuneration they may expect to receive.

Universities engage in graduate instruction not only to meet the needs of industry and the student, but also because it is an essential part of their overall mission. Undergraduate education, graduate education, and research are generally considered to be equally important, interrelated components of a balanced plan of higher learning. These three activities mutually complement and strengthen each other, especially when most faculty members partake of each. For centuries the great universities of the world have held it to be their purpose to advance knowledge by research as well as to disseminate it. And research supports education, for in practice the professor who devotes his efforts to repetitive teaching is likely to stagnate; if his teaching is to be fresh and lively he must be active himself. It has been said that [1]: "He who learns from one occupied in learning, drinks of a running stream. He who learns from one who has learned all that he is to teach, drinks the green mantle of the stagnant pool." There is no better means of keeping the mind alert and fresh than by the systematic practice of original and critical thinking which is a part of good research. Moreover a reciprocal relationship exists; teaching in turn contributes to research. The synthesis of new material for presentation to a class and searching questions from alert students often reveal gaps and inconsistencies in knowledge and suggest new researches to be undertaken.

Research is very closely related to

[1] Numbered references are listed at the end of this paper.

graduate education, since an appreciable part of the graduate student's program, at least a third if he is a doctoral candidate, is devoted to research. Here there is the apprentice system in which the student develops his professional competence by performing educational tasks of increasing responsibility, at first under the close supervision of the professor. The student and professor constitute a partnership which accomplishes a research task, and in doing it interact with each other in such a way that education takes place. Moreover an environment characterized by such research activity also enhances undergraduate education; for when the undergraduate student learns new knowledge and principles that he sees being put to use around him, he too is stimulated to intellectual discovery and adventure.

Patterns of Graduate Study in the United States

Graduate education in engineering has for its goals the cultivation of the highest level of professional competence. It is directed towards the mastery of the basic and engineering science underlying the candidate's field of engineering; the development of his powers of analysis, understanding, and critical judgment; and the development of the ability to undertake independent, productive research.

Almost all of the graduate work in the United States is included in programs of two levels: (1) the doctoral program which requires at least three years of full-time study, and (2) the master's degree program which requires about one academic year of full-time study. There are other programs intermediate in length that lead to degrees, but they have small enrollments. Engineering colleges also offer a wide variety of short courses and conferences at post-baccalaureate level which have diverse purposes, but these are not considered to be graduate programs. The relative magnitude of the graduate programs in the United States is shown by the comparison of engineering degrees awarded in the year 1958–59 [2] in which there were 38,134 first professional (bachelor's) degrees, 6,615 master's degrees, 714 doctor's degrees and 138 other degrees, the last having requirements between master's and doctor's levels. Only master's and doctor's programs will be considered here.

These graduate degrees were awarded by 144 different institutions (nearly two-thirds of the engineering colleges in the country) among which there is considerable variation in pattern and practice. Accreditation by the Engineers' Council for Professional Development has not yet been implemented for graduate curricula. Nor is there regulation of graduate programs by any other outside agency. Each institution is responsible for establishing its own admission policy, its own degree requirements, and even the name of the degree itself. Often the policy-determining bodies include representatives outside of engineering; in fact, engineering may have only a minority representation. Coordination of the work in the different institutions is entirely voluntary and has led to a fair degree of uniformity in formal requirements although it is likely that standards of performance vary somewhat. While graduate degrees in general are accorded recognition and respect, their value depends in some measure on the reputation of the institution granting them.

The master's degree program begins where the baccalaureate program ends, but differs from it in having greater emphasis on science, engineering science, and mathematics, in being at a higher level, and in giving more responsibility to the student. In some institutions the courses are given in great breadth; in others much of the work is centered on specific engineering fields. There is considerable variation among institutions in the number of graduate courses that are offered; if the number is large, the student and his faculty adviser will plan a program to fit the individual's needs and in conformity with his over-all goal. Most of the work is taken in the student's major department. The courses usually are given by means of lectures or recitations, and also, if appropriate, by means of laboratory work. There are frequent assignments of work to be done outside of class; usually there are periodic examinations in each course and also final examinations. A specified number of credits is required, with grades above a prescribed

minimum, and most institutions require a thesis based upon research. The credit requirement is commonly 30 semester hours, of which about 20% may be allotted to the thesis if it is required. In some schools the students also must pass a general or comprehensive examination which may be written or oral or both.

Admission to a master's program is usually granted only to graduates of EC PD-accredited curricula who rank in the top one-fourth to three-fourths of the class. However, applications for admission are considered on their individual merits and account may be taken of the areas of strength and weakness of the applicant, any progressive improvement in the quality of his previous work, and the reputation of his undergraduate institution. Under some circumstances he may be admitted on the basis of taking more than the amount of work that is usually required.

The designation of the master's degree varies somewhat, the commonest being Master of Science in Civil (or other) Engineering which is abbreviated M.S. in C.E., the next most common being Master of Science, abbreviated M.S. or S.M. A few institutions use Master of Civil (or other) Engineering, M.C.E. For most students the master's is a recognized and respected terminal degree; for some it represents the first year of a doctoral program; in a few cases it is a "consolation prize" awarded to candidates who fail to qualify for the doctor's degree.

The doctorate is the highest degree earned in formal education in the United States and is based upon work which is judged by exacting standards. It is not necessary for a doctoral candidate to have a master's degree first although most of them do obtain it because they easily qualify en route to the higher degree.

Admission is more restrictive than for the master's degree; applicants ordinarily must rank in the top quarter to the top tenth of their baccalaureate class. They, too, are judged by more than grades alone; they must show the capacity for excellent performance in advanced study, and promise of ability to do original independent research. Sometimes an applicant will not be considered a candidate for a doctor's degree until he has actually demonstrated his ability at master's degree level.

The requirements for the doctor's degree include course work, thesis research, and proficiency in reading technical literature in one or two foreign languages. Qualifying and final examinations must be passed and these are independent of courses. In general, course work plays a less important role than in the master's program; in fact at some institutions there may be no specific requirement of course credits. The greatest emphasis is placed upon the scholarly and professional performance that is shown in thesis work, on the examinations, and in seminars.

The doctoral program is usually quite flexible and is adapted to the student's individual needs. Full-time students starting after the completion of the bachelor's degree usually devote most of the first two years to advanced courses in their major and minor fields, in which there is ordinarily great stress on mathematics, science, and engineering science. After most of the course work is completed, the student takes a qualifying examination to test his preparation for independent research. The qualifying examination may have both oral and written parts and may require several days. Usually the language requirement must be met before the student is eligible to take the qualifying examination. If he is permitted to continue, the student devotes most of his third year to his thesis research, at the end of which his thesis is carefully appraised and he is required to take a final examination which may be a public oral examination in which he presents and defends his thesis. The thesis is expected to make a significant contribution to engineering and some, though not all, institutions expect the thesis to be published, at least in part, in a professional journal.

The commonest name for the earned doctor's degree in engineering is Doctor of Philosophy, Ph.D., but other designations are used, such as Doctor of Science, Doctor of Engineering, Doctor of Engineering Science, often to denote similar programs.

One of the important characteristics of graduate study in contrast with undergraduate study is that it is undertaken in

an atmosphere of greater professional intensity. This may be attributable to the selection that has occurred, to the greater initiative and responsibility that the student assumes for his own education, and to his status, which is that of a junior colleague of the faculty. The graduate student shows a markedly greater seriousness of purpose and devotion to his studies than the undergraduate, is better able to ask the right questions, and takes more initiative in setting tasks for himself. And the teacher finds graduate work a joy and a greater challenge.

The transition to graduate work often involves a change of institution, which is encouraged by faculty advisers so that the student may gain the advantages of new points of view and working with a different faculty.

Most of the graduate students in the United States receive financial support, which they may earn as teaching or research assistants or sometimes as instructors, or the support may be in the form of a fellowship for which the student does nothing in return. A teaching assistantship is an official staff position, at the lowest level, usually paid out of institutional funds. The assistant's duties vary from grading papers to being in charge of an undergraduate laboratory under the supervision of a senior staff member. Sometimes he has even greater teaching responsibilities. The research assistant is part of a team working on a research project, often one that is sponsored by an outside agency. In some cases the work that he does as an assistant may be part of his thesis research.

The conditions of an assistantship are variable even at a single institution. At one extreme the student gives only a quarter to a third of his time, at a minimal stipend, and has enough time left to carry a full program of graduate work. At the other extreme he devotes most of his time to his duties, at a higher stipend, and with such teaching or research responsibilities that he may carry only about one-third of a full-time graduate program. There are, of course, many variations between these extremes; the more work expected of the student, the greater his stipend, and the less work he can carry as a student. It should be pointed out that some educators feel that teaching experience is valuable educationally to the graduate student, that the time and effort given as an assistant are well spent. Fellowships are grants to promising students to encourage them to undertake graduate work, and are most often supported by an outside agency: a company, a philanthropic or government organization. Particularly significant in the United States are the fellowships awarded by the National Science Foundation in many fields including engineering. Two types of fellowships are granted for graduate study: the regular graduate fellowship with a stipend of $1,800 to $2,200 per calendar year plus tuition plus an additional allowance for dependents, and the cooperative graduate fellowship with a stipend of $2,200 plus a grant of $1,800 to the school, part of which covers tuition. Application for the first is made directly to the Foundation and the fellow may attend the school of his choice; for the second, application is made to the school which has a part in the selection of fellows. In the year 1959–60, regular National Science Foundation graduate fellowships were offered to 175 of 807 applicants in engineering, cooperative graduate fellowships to 233 of 534 applicants. It may be of interest that the number of these awards in all fields of science including engineering was 1,100 of the first type and 1,050 of the second.

For simplicity I have described the graduate study programs as if they were undertaken by full-time resident students. However, many resident graduate students with teaching and research assistantships carry less than a full program with the consequence that they require more than three years, often four to six, to complete the doctoral program, and more than one academic year for the master's degree.

Also there are non-resident students in considerable numbers on a part-time basis. These are employed in industry and either take evening courses, or in some cases may be permitted to take a limited amount of regular day work. Often the employer pays the tuition. Companies support graduate work in order to improve the competence of their

engineers and as a means of recruiting good men. A qualified bachelor's degree graduate usually has to choose between graduate work and an attractive industrial offer. The former means several years at a relatively low level of financial support, and he may prefer to go to industry if his prospective employer encourages and supports graduate work on a part-time basis. In fact he may even choose a particular company from several who have made him offers because of the opportunity provided for graduate study.

It is perhaps only natural then to find that off-campus and extension centers develop to serve an industry or a large laboratory that is located at an inconvenient distance from the nearest engineering college. Companies invite colleges to conduct classes on their premises, especially for their employees, and sometimes offer extra inducements such as classroom space or a building, money to meet part of the costs or even the services of their engineers as part-time teachers. In this case the professor is brought to the students instead of the students coming to the professor. These programs are becoming more common.[3]

Educators in the United States have mixed feelings about such developments. Most would agree that off-campus graduate education is better than none at all, but that the best education is one that is conducted on a full-time basis, in residence at a university, and which permits the student to complete his work in the shortest time consistent with degree requirements. Studying on a part-time basis lengthens the period of education and subtracts from the engineer's productive years. On the other side, it is true that industry can provide a good professional atmosphere; but there remains the question of whether in practice the university retains an adequate control of off-campus education. Furthermore, the best education is more than the taking of courses; part of it comes from informal discussions with professors and students, part of it from seminars, part of it from the use of a good library, and part of it from wandering outside of the boundaries of a particular field. These advantages are rarely found in off-campus study. Their value is recognized in the requirement that almost all institutions have for the doctorate (though not for the master's degree) of at least one year of full-time work in residence, usually the last year devoted to thesis research. Companies are showing a growing tendency not only to give employees leaves of absence, but also to support them generously during this period.

The historical and statistical position of graduate work in engineering in the United States may be of interest. The first graduate degree was a doctorate conferred in 1869; the first master's degree was awarded in 1879. Only six institutions had given advanced degrees by 1890, and until 1920 fewer than 10 doc-

TABLE I

GROWTH OF GRADUATE EDUCATION IN THE UNITED STATES

Year	Bachelor's Degrees		Advanced Degrees				
	No. Inst.	No. Degrees	No. Inst.	Master's	% Total	Doctor's	% Total
1925–26	n.a.	7,400	n.a.	630	7.84	10	0.12
1935–36	n.a.	8,847	n.a.	735	7.60	82	0.86
1940–41	n.a.	11,358	n.a.	1,358	10.54	174	1.35
1945–46	130	7,381	91	988	11.69	84	0.99
1950–51	192	37,887	124	5,134	11.77	586	1.35
1955–56	215	23,547	130	4,678	16.22	610	2.11
1956–57	219	27,748	124	5,203	15.51	596	1.78
1957–58	223	31,206	144	5,669	15.10	647	1.72
1958–59	231	33,695	144	6,615	16.14	714	1.74

Data from *Facilities and Opportunities for Graduate Study in Engineering*, ASEE, March 1958, and *Journal of Engineering Education*, various volumes.

TABLE II

COMPARISON OF GRADUATE DEGREES IN SEVERAL FIELDS, 1959–60

Field	Bachelor's (B)	Master's (M)	M/B	Doctor's (D)	D/B
Chemical Eng.	3,013	591	0.20	143	0.048
Civil Engineering	4,939	919	0.19	70	0.014
Electrical Eng.	9,837	1,794	0.18	189	0.019
Mechanical Eng.	8,300	1,056	0.13	83	0.010
Metallurgical Eng.	710	199	0.28	63	0.089

From *Journal of Engineering Education*, vol. 50, No. 6, 1960.

torates were conferred in engineering per year. The pattern of growth is shown in Table I where data for bachelor's degrees also are given for comparison. These are the engineering degrees given by all United States institutions. The ratios of master's and doctor's to total degrees are shown, also the number of institutions awarding bachelor's and advanced degrees, respectively, for the years for which these were available. The increase of graduate work since World War II is attributable, at least in part, to the great impetus given engineering and applied science by weapons development which led to a greatly enhanced understanding of the importance of advanced technology in non-military enterprises as well.

Although many institutions offer graduate programs, there are wide differences in enrollments and degrees awarded. For example, in a study of doctor's degrees conferred in the seven years, 1950–56,[4] it was found that only 10 schools awarded 55% of the doctorates; only twenty, 77%; and only thirty-four, 90%.

Similarly, the extent of graduate study varies from field to field. Table II gives the number of master's and doctor's degrees and their ratio to the number of bachelor's degrees for five fields of engineering in a recent year, 1958–59. It may be seen that graduate study, especially that leading to the doctorate, is most commonly undertaken in metallurgical, least commonly in mechanical engineering.

Finally, it may be of interest to compare day and evening enrollment for the various degrees, as shown in Table III. Evening and special enrollment is appreciable in comparison with day enrollment only in the master's degree programs, but even so does not produce degrees in the same proportion because of the smaller academic loads.

Research

Most educators agree that research in an engineering college should be fundamental in nature; that is, directed towards the discovery of new principles and facts, or to the application of known principles in new analyses and syntheses of technological importance, or to the development of specific devices or processes that have value in the professional development of the student. Furthermore, it is generally agreed that the performance of routine practice or testing does not have a place in the university.[5]

Research is expensive; thus it is difficult to consider it apart from means of support. Before World War II, research was largely centered in the individual professor who pursued his own interests with little guidance or supervision by university officials. Support was minimal, at least by today's standards, and came chiefly from the university's own

TABLE III

ENROLLMENTS OF DAY STUDENTS AND OF EVENING AND SPECIAL STUDENTS, 1959–60

Program	Day Students Full-time and Part-time	Evening and Special Students
Bachelor's	211,127	31,865
Master's	17,084	12,271
Doctor's	4,725	918

From *Journal of Engineering Education*, vol. 50, No. 6, 1960.

limited funds, from foundations, and from industry. During the war, military agencies turned to the universities for much of the basic research that was needed, and provided them with adequate funds to undertake it. The value of university research was demonstrated and support has continued, not only for the sake of the research itself but also in the interest of education, especially at advanced levels.

The way in which support is used will be shown by a hypothetical example, in this case a research contract of a modest amount, about $25,000, which runs for one year. It is under the supervision of a professor and supports research that he would like to undertake; in fact, he himself initiated the proposal and submitted it to an agency after obtaining university approval. The budget includes part of the professor's salary during the academic year, so that his teaching load may be reduced and he will have more time for research, and all of his salary for two summer months. It will also include stipends for two research assistants who are graduate students, and other items as follow:

Professor—40% of $10,000 salary during academic year	$ 4,000
2 summer months at ⅙ of $10,000	2,222
2 graduate students at $3,000 during academic year	6,000
summer at $800 each	1,600
Fraction of secretary's salary	500
Fraction of machinist's salary	1,000
Travel and communication	300
Supplies	1,000
Equipment	2,000
Indirect costs	6,000
Total	$24,622

All of these items might show considerable variation depending upon the nature of the work, the personnel, and the items permitted by the sponsoring agency. For example, some contracts and grants will not pay any part of the professor's salary during the academic year; his work is considered to be part of the university's contribution. Indirect costs are much more limited in the case of some grants. Some schools give extra compensation to the professor but others regard this as an unwise practice.[6]

The support illustrated in the foregoing example is valued by the university because it facilitates research, supports graduate students, and helps make the professor's position more attractive by giving him more time to do research, students to work with, and other aid. On the other hand, he has to write periodic reports to the sponsoring agency, which many professors find distasteful. The example above is a relatively small project, although there are many still smaller as well as others that are larger by a factor of 10 or more. In the larger projects the professor's work may become largely administrative.

A comprehensive study by the National Science Foundation covering the academic and fiscal year 1953–54[7] showed that engineering colleges in the United States spent a total of 72.8 million dollars for research and development. This total includes the following components:

	Millions of Dollars
Separately budgeted research and development	64.4
Contributions of engineering schools to indirect costs of separately budgeted research	1.8
Departmental research	6.6
Total	72.8

Separately budgeted research is the research which appears clearly indicated on budgets as in the case of the preceding example. The second item includes some of the indirect costs, costs which because of their general or supporting nature cannot be directly assigned to a particular task. They include administrative expenses, heat, light, maintenance, library service and so forth. Some of this expense appears on the budgets, as in the example, but there remains an excess portion which the sponsoring agencies will not pay. Thus, there is a portion of the indirect cost that falls on the university. Some institutions feel that this limits the amount of grants that they can afford to accept.

Departmental research is that which is part of the day-to-day work of the

TABLE IV

SOURCES OF FUNDS SPENT BY ENGINEERING SCHOOLS FOR SEPARATELY BUDGETED RESEARCH AND DEVELOPMENT

Fiscal Year 1953–1954

Source		Millions of Dollars
Department of Defense		$47.7
Department of the Navy	18.5	
Department of the Army	12.1	
Department of the Air Force	17.1	
Department of Health, Education and Welfare		0.3
Atomic Energy Commission		4.0
National Science Foundation		0.2
Other Federal sources		1.5
Total from Federal Sources		53.7
Institutions' Own Funds		3.5
Private Foundations		0.6
Industry		6.3
Private Gifts and Grants		0.1
All Others		0.2
Grand Total		$64.4

Data from National Science Foundation Report.

faculty, and much of this item does not appear directly in budgets. In most colleges, faculty are expected to do research as well as teach and it is difficult to say what part of their salaries is for teaching and what part for research. There is a similar situation with respect to supplies, new equipment, and repairs when appropriations for these purposes may be used interchangeably for teaching and research. Thus, the third item in the table above is one that is hidden in departmental budgets.

Table IV shows the source of the 64.4 millions spent for separately budgeted research and development. Thus, $53.7 millions or 74% came from the federal government, chiefly from the Department of Defense, and the rest from industry, the colleges themselves, foundations, and other gifts and grants. The importance of federal support is clear.

The 64.4 millions for separately budgeted research are distributed quite nonuniformly among the institutions, of which only two, each with expenditures of 5 million or more, account for 29% of the total; and eighteen, with expenditures of 1 million or more, account for 76%.

The separately budgeted research undertaken by engineering schools was classified as basic research to the extent of 45% and applied research and development, 55%. The distinction is an exceedingly difficult one to make, but the National Science Foundation used the following definitions:

1) "Basic Research is that type of research directed toward increase of knowledge in science. It is research where the primary aim of the investigator is a fuller knowledge or understanding of the subject under study rather than a practical application thereof.

2) "Applied Research is that type of research directed toward practical applications of science. Development is the systematic use of scientific knowledge directed toward the production of useful materials, devices, systems, methods, or processes, exclusive of design and production engineering. It does not include quality control or routine product testing."

The National Science Foundation survey also showed that in engineering schools approximately one-half of the faculty members engage in research, and that one-fourth of the total faculty time is so utilized.

Problems of Policy and Procedure

There is a need to increase the output of men who have doctor's degrees, especially to serve in the teaching profession, but also in industry. The need for teachers is especially acute in view of great increases of enrollment that are expected to start in the next few years. In civil engineering, for example, 70 doctor's degrees were awarded in 1959, and only a fraction of the recipients of these, estimated as one-third, went into teaching. There are 135 colleges with accredited civil engineering undergraduate curricula and possibly 50 others. The average size of departmental faculty is nine, and in only a few institutions do half or more of the faculty have doctorates. Hence,

the demand for teachers in civil engineering with doctor's degrees is measured in hundreds, while the available supply may be counted in tens. Situations of the same kind exist in other engineering fields as well.

A closely related problem is that of financing graduate education, which is very expensive. This level of education makes great demands on the time of the best qualified faculty and requires the best laboratory facilities, apart from the support of graduate students themselves. Graduate education probably costs two to four times as much per student as undergraduate education and this is far more than the tuition charged. How to meet this difference and even increase the amount of graduate work is a serious problem to most institutions.

A basic policy question relates to the degree of specialization in the program; whether it shall be concentrated on a relatively narrow field or have breadth with only such specialization as is required by the thesis. There are good reasons for breadth if it is obtained by emphasis on mathematics, science, and engineering science, for this kind of education is needed to help the graduate to go beyond present practice. It is the rule rather than the exception that good engineers even at doctoral levels get into new fields which were unknown and hence not anticipated, and indeed often differ greatly from the thesis subject.

Another question is that of accreditation, which for some time has been planned by the Engineers' Council for Professional Development, but never implemented. The need of accreditation is growing greater because more schools are offering graduate work, sometimes with questionable standards. Moreover, growth of off-campus and extension graduate work under some inherently new conditions makes it desirable to determine what are minimum acceptable standards.

A specific question is the extent to which part-time faculty from industry should be employed in graduate education. Even if they are thoroughly competent, which may not be easy to judge, it is hard to develop the close team work with them that is characteristic of department faculties at their best.

Other problems relate to the quality and quantity of sponsored research. Ideally, the research is no different from that which would be undertaken with the university's own funds. However, in practice the sponsor may be willing to support only something that is different, often more specific than would be desirable, and then the university faces the problem of how far it should depart from its ideal in order to obtain support. Also the sponsor may ask for restrictions on publication as sometimes happens when support comes from the Department of Defense. Most universities will not accept such restrictions except in times of national emergency.

As to how much sponsored research is desirable, one approximate rule-of-thumb is that the departmental research budget should be about as large as the teaching budget,[8] for a department that has a doctoral program, or half as large if there is only a master's program.

Graduate work in engineering has followed the pattern of graduate work in science and is therefore directly aimed at preparation for research. However, there are other types of engineering activity for which advanced education is needed such as design and application, and it may well be questioned whether the research-oriented program is most appropriate for these or whether some other kind of program might be better.

Lastly, there is a beginning of postdoctoral education in the United States which also is following the pattern in science. This is a most desirable development and one that should be encouraged to increase. The problem that the institutions face is how best to integrate it into its over-all program, how to support it, and how to make it most effective.

The problems that I have mentioned are perhaps the most important of those that confront us; these and others are discussed in the *Manual of Graduate Study* [9] and *Facilities and Opportunities for Graduate Study in Engineering.*[10]

In the United States most of us feel that we still have much to learn about how to achieve optimum graduate work and research in our system of engineering education. One of the best ways to learn is by the exchange of ideas in meetings

and in journals, which we frequently do on a national scale. This meeting, which is international, brings a rare opportunity to exchange ideas that come from a much broader background and from more diverse sources. I am glad to be here participating and I look forward to a stimulating and productive discussion.

[1] B. Truscot, *Red Brick University*, Penguin Books, 1951.

[2] W. W. Tolliver and H. H. Armsby, "Engineering Enrollments and Degrees in ECPD-Accredited Institutions," JOURNAL OF ENGINEERING EDUCATION, Vol. 50, no. 6, pp. 450–467, February 1960.

[3] A. B. Giordano, "Part-Time Graduate Study in the New York Metropolitan Area," J. M. Pettit, "Part-Time Graduate Electrical Engineering Programs in the San Francisco Bay Area," S. S. Shamis, "The New York University Graduate Center at Bell Laboratories," JOURNAL OF ENGINEERING EDUCATION, Vol. 50, no. 7, pp. 574–591, March 1960.

[4] Private communication from Professor C. Richard Soderberg, Massachusetts Institute of Technology.

[5] E. A. Walker, "A Suggested Research Policy for the Guidance of Engineering Schools," JOURNAL OF ENGINEERING EDUCATION, Vol. 45, no. 2, pp. 171–172, October 1954.

[6] W. A. Koehler, "Faculty Compensation for Sponsored Research: Good or Bad?" JOURNAL OF ENGINEERING EDUCATION, Vol. 50, no. 7, pp. 569–571, March 1960.

[7] *Scientific Research and Development in Colleges and Universities: Expenditures and Manpower 1953–54.* National Science Foundation, 1958.

[8] R. A. Morgen, "Sponsored Research–Good or Bad?" JOURNAL OF ENGINEERING EDUCATION, Vol. 50, no. 7, pp. 565–568, March 1960.

[9] *Manual of Graduate Study in Engineering.* Graduate Committee of the American Society for Engineering Education. 1952.

[10] *Facilities and Opportunities for Graduate Study in Engineering.* Graduate Study Commission, Graduate Division, American Society for Engineering Education. March 1958.

[11] *A Survey of Research in the Nation's Engineering Colleges: Capabilities and Potentialities.* National Science Foundation. June 1958.

[12] H. L. Hazen, C. F. Prutton and J. W. Barker, "Encouragement of Fundamental Research as an Aid to Education and Engineering," JOURNAL OF ENGINEERING EDUCATION, Vol. 44, no. 1, September 1953.

[13] M. P. O'Brien, "Graduate Professional Education in Engineering," JOURNAL OF ENGINEERING EDUCATION, Vol. 44, pp. 545–552, May 1954.

[14] R. E. Kirk, "Cooperative Engineering Education at the Graduate Level (From the Viewpoint of the Graduate School)," T. M. Linville and K. B. McEachron, Jr., "Cooperative Engineering Education at the Graduate Level From the Viewpoint of Industry," N. J. Hoff and V. L. Salerno, "Graduate and Research Work in Universities and the Use of College Men in Industry and Government," JOURNAL OF ENGINEERING EDUCATION, Vol. 40, 1949.

[15] F. C. Lindvall, "Postgraduate Engineering Education in Industry and the Community," JOURNAL OF ENGINEERING EDUCATION, Vol. 48, no. 9, May 1958.

REACTOR LABS DOUBLED AT PENN STATE

Pennsylvania State University is more than doubling the size of its nuclear reactor laboratories to meet increased demands for research and educational services.

Acting Director Forrest J. Remick said the power rating of the Penn State reactor was doubled to 200 kilowatts (heat output) in June, and that consideration is being given to increasing the power rating to 1,000 kilowatts. The national Science Foundation has awarded the University a $168,000 grant to provide auxiliary equipment designed to increase the efficiency of the reactor.

Construction will begin next spring on a $440,000 addition to house additional research activities at the reactor. Funds will be supplied by Pennsylvania's General State Authority.

Engineering Faculty Recruitment and Development in the United States of America

W. L. EVERITT

Dean of Engineering, University of Illinois
and President, Engineers' Council for Professional Development

It is a great pleasure and honor for me to participate in this conference on engineering education which will help those of us who are working in this field to understand better what is going on throughout the countries of South and North America. We already have come to know each other as friends by direct contact and through the exchange of students, and we hope that this conference will strengthen these ties and help all of us to benefit from the growing strengths developing in all our countries.

While the conference sessions and the papers offered by the U. S. A. delegation are divided into several areas, problems of student selection, faculty development, curriculum design, and professional practice are so intertwined it is impossible to discuss any one feature without making continual reference to the others. Our organizations, both within the university and on a national level, are all intended to assist in a common forward movement.

Engineering education in the United States of America is offered in about 230 institutions. The group accredited by the Engineers' Council for Professional Development (to be described later) includes 155 schools, but these give 85% of the degrees. These educational institutions are located in all 50 states, Puerto Rico, and the District of Columbia. They have varying traditions and differ in the sources and level of their financial support. Most are organized as engineering colleges within a general university, but an appreciable number are independent institutes of technology.

With such variety, one cannot say, "Such and such is the practice in the U. S. A." with regard to faculty recruitment and development, because these practices vary more widely than do the curricula. However, one feature that is common and that should be stressed is that our universities and institutes of technology are staffed almost entirely by full-time faculty members who devote their primary efforts to teaching and research on the college campus. They must be recruited in competition with industry.

Almost universally, teaching faculty members are not merely allowed but also encouraged to engage in research, writing, and independent consulting, but those active in consulting work do not ordinarily average more than one day a week in this activity. For the majority of faculty men, consulting involvement is negligible during the academic year. A few institutions use engineers from industry to staff evening programs, but only a small proportion of our graduates complete their work in such evening programs.

The United States of America is almost unique among the nations of the world in not having any centralized governmental control of higher education of the form of a Ministry of Education. While our federal government does have a Department of Health, Education, and Welfare, which includes an Office of Education, this organization operates primarily as an agency to collect and disseminate statistics and does not have administrative or coordinating functions.

Our institutions themselves are interested in and responsible for the develop-

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ment of adequate standards and continually improving programs. This is accomplished largely through the internal efforts of the faculties themselves, but coordination of common objectives and maintenance of acceptable standards are developed through voluntary national organizations. Of particular interest are the American Society for Engineering Education (ASEE) and the Engineers' Council for Professional Development (ECPD). The ASEE is primarily an association of individual faculty members, supported to some extent by the engineering colleges as Institutional Members, and private companies as Industrial Members. A voluntary association, its membership includes more than half of the engineering teachers of the United States and Canada. Educators from all parts of the world are also welcomed into membership and many have joined. ASEE conducts an annual five-day meeting in June, at which vital topics related to the improvement of engineering education are discussed. It also conducts some sixteen sectional meetings each year, and a variety of special conferences and short courses. It has 22 divisions, some devoted to particular curricular programs such as Civil Engineering, Mechanical Engineering, etc. and others covering broad interdisciplinary interests such as Graduate Studies and Relations with Industry. Various studies of the divisions and committees are published as reports in both the JOURNAL OF ENGINEERING EDUCATION and as reprints. Some of these reports will be discussed later in this paper, and are available for purchase from the Secretary's office at the University of Illinois. ASEE's activities have a major impact on the development of engineering faculties, as will be indicated later in this paper.

Accreditation

The ECPD is an intersociety organization whose members include five of the older technical societies, as well as the Engineering Institute of Canada, the American Society for Engineering Education and the National Council of State Boards of Engineering Examiners. One of its major activities is the accreditation of engineering curricula. The need for this grew out of the development of Professional Registration in the several states. In the laws of these states relating to the procedures required for registration, there is usually a reference to certain rights of "graduates of an accredited institution" (such as exemption from a portion of the required examinations). It was early recognized that separate accreditation of educational institutions by each state would be an intolerable burden on these institutions. A common organization for accreditation is necessary since the graduates of even state universities disperse throughout the nation upon graduation and register in every state. Hence, in 1932 the ECPD was organized to provide the national engineering accreditation system now recognized by all states. ECPD did not confine its activities to accreditation but its functions have expanded into the areas of high school guidance, student development, post graduation professional development, ethics, and other fields involved in the intellectual growth of the engineer which can be handled best on an intersociety basis.

Accreditation is an activity which appears to be unique to the United States of America. It is conducted by a visiting team selected by the accrediting agency, associated with a particular profession, which for engineering is the ECPD. This team visits the educational institution, consults with the faculty and administration, examines the facilities and curriculum, the academic standards and financial support, and determines whether they meet certain minimum standards. After leaving the institution, the visiting committee prepares a report to its parent body recommending for or against accreditation. Such accreditation is for a limited period; in the case of ECPD this may be from one to five years. A short-term accreditation indicates that minimum standards have been met, but there is reason for concern as to whether the institution might fall below acceptable standards in the near future. At the end of the accreditation term, a reexamination is required, usually by a visit, to determine the situation at that time. In the U. S. A. each professional group—law, medicine, engineering, etc.—operates its own accreditation system. In ad-

dition, six regional associations examine the universities or other educational institutions within their geographical areas to assess the quality of the institution as a whole and determine whether credits from one institution will be accepted by another. ECPD requires such overall accreditation of an institution before it will consider inspection for approval of the engineering curricula. It must be recognized that student populations are quite mobile in the U. S. A. and approximately half the graduates do not start at the institution from which they receive their diplomas.

Accreditation visits to institutions are only made by ECPD upon invitation of the college concerned, and upon payment of a fee equal to the average cost involved. Nevertheless, the prestige associated with accreditation is such that I know of no institution which has not requested examination as soon as it thinks it can qualify. Some 155 institutions are currently accredited for most of their engineering curricula. It is quite probable that Dr. Lindvall will also discuss accreditation, since he is currently Chairman of the Education and Accreditation Committee of ECPD and this activity has a major influence on curricula.

In the educational process, the student is more important than the faculty, and the quality and devotion of the faculty are, in turn, more important than the curriculum in developing a strong educational program. Hence, in educational accreditation visits primary emphasis is placed upon an examination of the quality of the faculty.

The ASEE Evaluation Report

In the development of an adequate faculty, primary responsibility must rest necessarily with the educational institution itself. However, it is undoubtedly true that the communication developed by ECPD and ASEE has improved engineering educational programs and standards for faculty throughout the country.

In 1951, ECPD took a step which has had a major impact on engineering education in the U. S. A. It asked the ASEE to make an evaluation of engineering education. ASEE appointed a committee of some 40 leading educators who spent three years on the task—presenting a Preliminary Report in 1953, an Interim Report in 1954 and a Final Report in 1955.[1]

This committee was supported by over 100 institutional committees located in individual engineering colleges who made studies of their own, criticized the national reports, and also made constructive suggestions. The Final Evaluation Report (also referred to as the Grinter Report) emphasized the need for strengthening the work in the basic sciences, including mathematics, in the engineering sciences of solid and fluid mechanics, thermodynamics, electrical theory, transfer and rate mechanisms, and scientific foundations of the properties of materials. It reemphasized the need for adequate treatment of the social sciences and humanities and also outlined objectives of the engineering courses in analysis, synthesis, and design.

A portion of this Evaluation Report (in the writing of which I took an active part) devoted particular attention to faculty selection and development. The tone of its emphasis on a scientifically oriented curriculum has also had much influence upon the development of engineering faculties and the type of individuals currently being sought as new members of the teaching staff. I will quote certain excerpts as they give insight into the thinking of many leaders in engineering education in the United States. Although this report was completed five years ago, the principles contained therein have not changed. They now are quite generally accepted, and implementation has been moving forward.

"The Selection and Development of an Engineering Faculty

"Distinguished faculties are far more important to the advancement of engineering education than details of curricula or magnificence of facilities. The university is a community of scholars and as such requires

[1] "Final Report of the Committee on Evaluation of Engineering Education," L. E. Grinter, Chairman, Journal of Engineering Education, September 1955, Vol. 63: No. 1, pages 26–60. Available as ASEE reprint.

outstanding teachers to attract outstanding students. To improve and develop courses or curricula, to build up facilities—in short, to command respect as an educational institution—all require a faculty of competent teachers and scholars.

University and College Environment

"The academic and professional development of an engineering faculty can proceed only in a favorable environment. More important than physical surroundings is the intellectual atmosphere; that is, the attitudes and ideas of the people who comprise the university. There must be encouragement of intellectual growth and opportunity for professional development. The development of such a favorable academic atmosphere should be the concern of all faculty members, particularly those in senior administrative posts.

"Physical surroundings also contribute to a favorable environment. Besides adequate classrooms and laboratories, the individual teacher needs appropriate office space, research facilities, technical services, secretarial help, and an effective library. An adequate library, its accessible location, and its required use are essential elements in any educational process.

"The atmosphere of a university has a significant influence on student progress. Students need a close bond of mutual interest and friendship with members of the faculty. They need objective guidance and encouragement in their intellectual growth; they need sympathetic understanding of their personal problems; but above all, they need the realization that they are being treated as individuals.

Qualifications of Teachers

"Any teacher at the university level must have notable intellectual capacity and a sustained interest in a life of study for continuing mastery of his field. To teach well, he must know and understand, clearly and in perspective, his own and supporting fields at a much more penetrating level than that required in his lectures.

"The engineering teacher, in addition, must have a full appreciation of the goals to be achieved. He should realize, first of all, that a course can be taught either as a narrow specialty or as a liberal subject in a professional curriculum; he should strive for the latter. Such a liberal course is one in which the teacher inspires his students toward creative endeavor and intellectual development not only while they are in college but also throughout their careers. It is one into which he brings recognition of the importance of intellectual honesty and professional integrity. To achieve these goals he should possess energy, enthusiasm, and a sincere interest in the development of men. To be fully successful he must exercise judgment and tact, and have the ability to meet the minds of his students. *He should perform creative work whether it be in teaching, writing, research, or professional activities.*

"Good teachers have always been personally creative and capable of inspiring their students to creative endeavor. In the past they necessarily emphasized the art or practice of engineering. However, during the lifetime of present faculties the art of engineering has come to depend greatly upon basic and engineering science. It must also be recognized that universities are better equipped to teach the science underlying professional practice, whereas industry is better adapted to provide experience in practical applications. Within a faculty there should exist a balance of experience in both the science and the art of engineering.

Education and Experience

"For a relatively young candidate for a faculty position, the strongest evidence usually available to measure a background of integrated fundamental knowledge and probable creative ability in teaching and research is an education which includes the doctor's degree. However, unless an academic environment is provided that will stimulate and retain men with an interest in creative work, mere insistence on degrees will not insure high quality in a faculty. For experienced persons, evidence of the capacity of the individual for creative teaching and research may be gauged by other criteria, and the formal educational background is of less significance.

"Appropriate professional experience in industry, government, or private practice is important in a well-balanced faculty. This experience should be considered in the selection and advancement of individuals, but it need not be a requirement for faculty members with a special educational background or with demonstrated creative ability in research or teaching. Every teacher, regardless of his background, should strive to become a recognized expert in his field. There is no substitute for knowledge of subject matter far beyond the limitations of that to be taught. However, it is recognized that mastery of subject matter alone will not guarantee good teaching and that neither in-

dustrial experience nor advanced degrees are adequate criteria in themselves. The minimum essentials for good teaching are the mastery of subject matter and the capacity of the teacher to draw students into active participation in the learning process.

Recruitment of a Faculty

"Of paramount importance to any profession is the personnel of that profession.

"New teachers are often recruited from among those students who have just finished study of a part of the wide field of engineering and science. It is recommended that promising undergraduate and graduate students be sought out and their aptitudes as potential teachers be appraised early in their schooling. If a student's interest is aroused in a teaching career, his study may be guided to embrace breadth of view and scholarly attitude.

"The effective recruitment and retention of a qualified faculty will require, in colleges of engineering, the establishment of a salary scale comparable to the income earned by outstanding practicing professional engineers as indicated by the published surveys of national societies.

"In faculty recruitment, industrial or other experience is an important measure of professional qualification. However, one needs to look very closely at the nature and character of this experience to determine its relevance to engineering teaching. Of greatest significance is not the number of years of experience, or even the administrative responsibility that the individual may have carried, although these are not unimportant, but rather evidence of the use of intellectual qualities in professional practice, such as creative design or development, including patents, and research contributions involving reports and publications, or other experience of an analytical or creative nature. One might appropriately ask the following questions. Can the potential teacher articulate his engineering work with the underlying basic science and engineering science? Has his work been such that it has kept his background of science alive or, better yet, in continuous development? Many practicing engineers achieve results by the use of a kind of intuitive sense which, no matter how successful in practice, cannot be transformed into organized knowledge that can be taught to engineering students.

Development of a Faculty

"Even though the environment and salary scale of an engineering college may be such as to attract and retain an outstanding faculty, the newer members of such a group will usually need guidance in the techniques of teaching. The primary purpose of an engineering college is to provide effective instruction in subject matter through the stimulation and motivation of students, and it is essential that those selected to teach be trained properly for this function.

"Although experienced teachers will generally perform more effectively than young instructors or graduate assistants, it is possible to achieve excellent results with the latter. Graduate student teachers usually bring into the classroom a youthful vigor, an enthusiasm, and a fresh point of view that are highly commendable. They may also lack professional judgment and maturity to such an extent that they may not give the undergraduate student a sufficiently balanced kind of teaching. Furthermore, teaching is a beneficial part of the educational experience even for those who later elect industrial pursuits.

"Seminars, discussion groups, formal and informal conferences between experienced and inexperienced teachers can all be used effectively for the development and growth of a faculty.

"It is important that faculty members set an example for their students by their membership and active participation in professional and technical societies, by becoming licensed engineers, by study of current literature, and by demonstrating interest in new developments and in research.

"In engineering teaching, continual contact with the forefront of engineering and scientific progress is essential. Leadership in scientific and engineering progress has frequently stemmed from university research activities. *The engineering teacher carries a responsibility to contribute to the advancement of knowledge through engineering research. The university must provide the opportunity to realize this objective in terms of time, facilities, and assistance.*

"It is only when teachers of professional subjects are recognized as experts that they have an opportunity to do consulting work. Hence, the ability to engage in such consultation is not considered to be a major factor in the recruitment of young teachers. Consulting practice should be considered as a means of developing and further strengthening an engineering faculty. Close association with engineering work or research in industry should stimulate the teacher and improve his teaching. Consulting is also a source of ideas for research.

Evaluation of a Faculty

"Evaluation of the potential of prospective faculty members and of the achievement of the existing staff ranks with the development of a progressive atmosphere as a most important function of a university administrator.

"The fact that evaluation of the progress of a faculty member must be based on judgment involving many factors indicates that administrators at each level should inform themselves of the viewpoints of their faculties before reaching these judgments. In particular, the faculty should be informed as completely as possible concerning the methods used in evaluation.

"Evaluation, to be effective, should be objective, and it should include along with other factors emphasis upon:

1. The effectiveness of the individual's teaching based upon his knowledge of subject matter, intellectual capacity, judgment, professional and personal stature, and qualities of personal leadership as shown in his ability to inspire students.
2. His productivity in research and other creative areas including new methods of presentation of subject matter.
3. His professional development as evidenced by progress in early years toward advanced degrees, by accomplishments in engineering practice, or by attainments and recognition as a scholar in his field.
4. His significant publications.
5. Evidence of his professional interest as shown by his activity in professional societies and in governmental and community affairs, and by his registration as a professional engineer.
6. The nature and responsibility of his consulting services to other areas of the university and to outside organizations."

CDEF Activities

In 1956 the American Society for Engineering Education undertook another major study by appointing a Committee on the Development of Engineering Faculties (CDEF). It was realized that the rise in birth rate following World War II will require facilities and staff for double the number of engineering students in our engineering colleges in the not-too-distant future. The Committee devoted itself first to a study of the task ahead. This required a skilled statistician and W. H. Miernyk, Professor of Economics at Northeastern University, was chosen as Executive Secretary for the task. In 1958 CDEF published the result of his study,[2] which predicted that in the decade 1957–67 the following increases would occur:

	Per Cent Increase
Undergraduate enrollment	66
Master's degree enrollment	93
Doctor's degree enrollment	115
Engineering teachers required	76
Average Engineering teaching salaries	105
Total Engineering teaching salary bill	233

Allowing for retirements and other losses, this would indicate a need for approximately 1,000 new engineering teachers per year for the next decade.

The study also brought out the fact that in 1956–57 the engineering colleges of the country had about 9,100 faculty members in the ranks of instructor, assistant professor, associate professor and professor and that there were currently some 732 unfilled positions for which personnel could not be secured (at least at the salaries available).

In the academic year 1959–60, a new but more limited survey by CDEF of some 116 institutions indicated that undergraduate enrollment had not risen as expected; rather it had declined by 7%. However, graduate enrollment had risen 44%. Using the reports from the survey, it was estimated that the total faculty in engineeirng colleges had actually risen to 10,400 and yet there were still some 656 unfilled openings. It was also estimated that because of replacements and resignations, the engineering institutions had appointed some 2,159 new members in order to achieve the actual increase in staff of 1,300. It should be remembered that the major impact of the increased birth rate has not yet reached the universities but is due in about three more years.

Hence, the estimate of a need for 1,000 new engineering teachers per year was justified, since in three years 2,159 staff members had been added and yet there were unfilled vacancies for 656.

[2] W. H. Miernyk, "Engineering Enrollment and Faculty Requirements 1957–67," JOURNAL OF ENGINEERING EDUCATION, May 1958, Vol. 48: No. 9, pages 789–859. Available as ASEE reprint.

The Evaluation Report has brought increasing recognition to the fact that universities must place major emphasis on scientific fundamentals, on the "why" rather than the "how," on what the university can teach best (leaving to industry the task of education in the practice and art of engineering). This change in emphasis has increased the demand for teachers who have obtained Ph.D. degrees. However, the expansion of industry into new scientific areas such as solid-state devices and gas dynamics has also created demands for engineers with advanced degrees. In 1958–59, the U. S. A. graduated only 714 Ph.D.'s in engineering. Less than 40% of these went into education. Hence, it is apparent that much of the teaching will necessarily be done by individuals without the educational background which might be desired. Included among these teachers must be graduate students who are themselves working for advanced degrees. This is becoming the accepted way of beginning as an engineering teacher.

We have found that a period of teaching during graduate work has advantages for all concerned. The graduate student finds that in analyzing his subject in preparation for presenting it to the undergraduate student he strengthens his own understanding of fundamentals in a way which cannot be duplicated by any other method. The student he teaches also finds the youth of the teacher often makes him more understanding of the difficulties involved, and the university finds that only if a graduate student has the opportunity to teach does he become intrigued with the possibilities of teaching as a career. After all, in contrast with situations in many academic fields, an engineer, when he chooses to prepare for the profession, decides that he would like industry. Hence, definite steps to give experience in teaching before a graduate has left the university are almost essential if engineering education is to attract the needed personnel to its ranks. But the use of increasing numbers of graduate students as teachers lends emphasis to the statement in the Evaluation Report, "Newer members of such a group (of faculty) will usually need guidance in the techniques of teaching."

Until a few years ago the practice in the U. S. A. with respect to recruitment and development of faculties was often quite haphazard. When a graduate engineer indicated he would like to teach, he was welcomed with open arms. But his introduction to teaching all too commonly consisted in assigning him to a class, giving him only a set of experiments or a textbook, and leaving him to his own devices. If the course was taught by several instructors, a syllabus or outline of topics was added, and he was made a member of a departmental committee conducting the course and discussing its objectives. During the years when our engineering colleges enlarged their staffs by only a small percentage in any given year, this method worked surprisingly well. In universities, engineering faculty members were quite generally considered among the better teachers. This was a tribute to the innate capabilities of our staffs and the fact that there was time to experiment and grow. Also, the first engineering teaching experience was generally confined to the laboratory with an older teacher available when the younger man needed help.

Recent rapid expansions in industry and in engineering enrollments has changed the situation with regard to both the problem of recruitment and the need for more rapid development of engineering faculties. As indicated, new faculty in the levels of instructor and above represent about 10% of the total. Hence, the most progressive institutions have been changing their practices and programs. The need for such changes was clearly indicated by the sections I have quoted from the Evaluation Report. At the national level the Committee on the Development of Engineering Faculties has devoted its attention in the years 1958–60 to a national study of new and successful practices in these areas, and to the preparation of material intended to help attract able graduates into the teaching profession. It has issued a report[3] published in the May 1960 issue of the

[3] Harold A. Foecke, Executive Secretary, CDEF, "Engineering Faculty Recruitment, Development and Utilization," JOURNAL OF ENGINEERING EDUCATION, May 1960, Vol. 50: No. 9, pages 757–828.

JOURNAL OF ENGINEERING EDUCATION. Harold A. Foecke, Assistant Professor of Electrical Engineering at the University of Notre Dame, served as Executive Secretary for the period of this study.

A booklet entitled "Teaching Tomorrow's Engineers" was prepared and some 20,000 copies distributed. This publication emphasized that teaching was an engineering career of the most challenging sort. It also emphasized the importance of resident graduate work for able students and pointed out that enrolling for such a program does not commit one to teaching, but lack of such enrollment is almost certainly a definite decision against such a career. CDEF also emphasized that in view of the fact that industrial recruitment of graduates is so intense, it becomes the responsibility of every engineering teacher to present the excitement and advantages of a teaching career to his better students in order that they may have full knowledge of the alternatives available. The key to recruitment for faculties is felt to be with the teachers rather than administrators, although the latter have the responsibility of providing an atmosphere conducive to attracting engineers into teaching and retaining them in the field. A teacher devoted to his subject and to his students may be the strongest single factor in drawing students into the teaching profession.

In order to study institutional developments in recruitment and development, Professor Foecke visited some 29 institutions and corresponded with many more to obtain typical samples of planned programs. The number and effectiveness of these are growing. They generally take the form of orientation programs, organized seminars on teaching principles, discussions among teachers of a common course, or consultation with and monitoring by experienced professors as group leaders. There is relatively little activity in the form of courses for credit given by Professors of Education such as is common in the preparation of secondary school teachers.

Three levels of faculty development have been identified. They are:

1. Development of specific teaching skills.
2. Development of general teaching competence.
3. Development of general educational competence.

The first two are a necessity for the new teachers; the last is essential if we are to have them develop into educators, men who can initiate and guide programs as well as teach courses. However, most organized programs at institutions deal with the first two levels while the activities of the ASEE are directed largely to the third.

As an example of a particular program, the Pennsylvania State University recently conducted a Summer Institute for Young Engineering Teachers on Effective Teaching sponsored by the Ford Foundation, the ASEE and the ECPD. Topics which were discussed included:

1. Engineering Education: Objectives and Place in the Academic World
2. Principles of Learning
3. Optimizing Learning in Lecture, Recitation and Laboratory Classes
4. Teaching Aids
5. Tests and Examinations
6. Stimulating Creativity
7. Instructional Planning
8. Course and Curriculum Planning
9. Evaluation of Teaching
10. Research in Engineering Education
11. Developing Professional Attitudes

Leaders in the fields of psychology, education, and engineering were included as program lecturers and seminar directors.

Not only did this institute give selected young teachers an opportunity to study and practice successful teaching procedures, but a somewhat older group were included who had expressly indicated that they and their institutions were interested in conducting similar institutes at other locations next summer.

The details of the many programs studied by CDEF are too extensive to discuss in this paper, and I must refer you to the committee report. It shows a growing effort in the U. S. A. to increase the effectiveness of the young faculty member as a teacher and do it while he is still young. Increasingly, this is undertaken while he can still be sub-

ject to helpful criticism without losing his dignity, while he is still considered a learner in all aspects of his new profession. As engineering itself grows out of the "cut and try" empiricism of the past, engineering teaching must also take a more critical and scientific approach to secure the effectiveness needed to handle the increasingly difficult tasks of the future.

In the U. S. A. we are frank to admit that we have not solved our problems of faculty recruitment and development, but we are working on them, some groups with great ardor and others with less. Many of these problems are similar to those in other parts of the world. I have studied them briefly in such varying places as India and the Soviet Union. I was amazed to find how many of our problems were mutual ones. I am sure the members of this conference too will find that our similarities are greater than our differences and that we can each leave with ideas applicable to our own countries. Again, I express my gratitude and enthusiasm at the opportunity to exchange experiences with you.

NUCLEAR ENGINEERING AT NEVADA

A step towards the full development of a nuclear engineering program at the University of Nevada was taken in November with the arrival of the first major piece of laboratory equipment, Dr. David Dickinson, department chairman, announced.

A nuclear simulator which mimics the operation of a full-scale nuclear reactor has been acquired. The simulator, about eight feet wide, five feet high and two feet thick, is about the size of a set of filing cabinets grouped together.

It is a training tool, Dr. Dickinson observes, and is "our first piece of laboratory equipment in the nuclear engineering program and one which will aid the program considerably." A sub-critical assembly is also housed on the University campus.

To be offered at the University of Nevada is the master's degree in nuclear engineering.

WOMEN IN ENGINEERING

Rensselaer Polytechnic Institute has announced a new program designed to open its doors to young women who want to study engineering, science and architecture.

In a joint statement issued by their presidents, Rensselaer and its Troy neighbor, Russell Sage College, a liberal arts school for girls, said they will undertake in September, 1961, a program of affiliation whereby the female students will live at Sage and study at Rensselaer.

"It will be possible for women to earn engineering, science and architecture degrees at Rensselaer while enjoying the residential facilities of Sage and social and extracurricular life of both colleges," the statement said.

"We hope this program will have the two-fold benefit of helping to increase the nation's professional engineering and science brainpower while making more efficient use of existing independent college facilities."

Registration of Professional Engineers in the United States

JAMES H. SAMS

Executive Secretary
National Council of State Boards of Engineering Examiners
12 September 1960

Registration is required of all engineers in the United States when their work affects the life, health or property of the public. Laws have been passed by the fifty-three states and jurisdictions that list the qualifications required of those who wish to offer their engineering services to the public. These laws provide for a State Board of Registration for Professional Engineers to license those who meet these qualifications.

Engineering has reached its present recognition as a profession because of the wise use of the engineering knowledge, skills, and creative accomplishments of those who have preceded us. Their willingness to make available to us, and to future generations of engineers, their accumulated knowledge and expertness in their work have done much to develop the profession of engineering. In considering the subject of registration of professional engineers, it is therefore appropriate to briefly review the philosophy of registration and the history of licensure in the professions.

Philosophy of Registration

The public has given us the exclusive right to practice engineering and it can take away or modify that privilege at any time. As long as we serve it better than someone else by insisting that high standards of education and experience be met by those who offer their professional services to the public, we shall merit its confidence and trust. The public is going to be served in any particular field by those who serve it best, whether they be engineers, lawyers, doctors, ministers or laymen.

Consider the difference between a business and a profession. In a business transaction, each participant is assumed to be equally well informed and equally able to hold his own in the give and take of trade and barter. The well known maxim of the law warns: "Let the buyer beware." At the other extreme stands the professional man, presumably better informed in his specialty than the layman and serving as the champion and protector of his client or patient. By its very nature, professional service requires a relationship of trust and confidence. In order to receive the best engineering service, a client must reveal to the engineer secrets of his finances and business which are frequently of the most intimate nature that should not be revealed to others. Thus, the requirements that make it possible to render the best service by a highly skilled, trustworthy professional man are those which also make possible the ruination of a profession if those in whom such confidence is placed happen to be charlatans or shysters.

It is at once obvious that a professional man cannot treat such a relationship lightly. The methods of licensure must insure that those seeking to enter the practice of the profession are adequately trained to render skilled service and that they are ready to accept the responsibility of protecting those whom they serve.

Presented at the Pan American Congress on Engineering Education at the Pan American Federation of Engineering Societies, Buenos Aires, Argentina, September 12–17, 1960.

There are those in every profession who are so unaware of the nature of a profession and so willing to exploit it that they would ruin it. A step or two above these is another group, frankly resentful of any obligation to render any service beyond that which is involved in giving their best technical effort to their individual paying clients. This is an unfortunate attitude for professional men who seem to be unaware of their other professional obligations. The leaders of the various professions recognize that professional obligations go much farther than devoted and skillful service and these are stated in professional oaths and canons of ethics.

Hippocrates' oath as used in the medical profession, the ceremony of the Iron Ring in Canada, and the Canons of Ethics for Engineers which is published by the Engineers Council for Professional Development are typical of these oaths and canons.

The Canon of Ethics for engineers states in its foreword: "Honesty, justice, and courtesy form a moral philosophy which, associated with mutual interest among men, constitutes the foundation of ethics."

"As the keystone of professional conduct is integrity, the engineer will discharge his duties with fidelity to the public, his employers, and clients, and with fairness and impartiality to all. It is his duty to interest himself in public welfare and to be ready to apply his special knowledge for the benefit of mankind."

This is the philosophy of the engineering profession.

History of the Registration Movement

When the life, health or property of the public is imperiled by unqualified or unscrupulous individuals, the public will soon insist on their legislative bodies passing a law to protect them and setting up agencies to determine that those who offer to practice the profession are properly trained and qualified to do so.

These laws, affecting some work now covered by engineers, go back many centuries. Since 1800 B.C. there have been laws to protect the public from those not qualified in certain fields. Hammurabi developed a code about eighteen hundred years before the time of Christ, but the process of legally certifying an individual for competence in advance of practice came nearly three thousand years later in 1140 A.D. when Roger, King of Normandy, required doctors to have a certificate of competence before they could practice. In the United States, it was not until 1883 that the dentists established the National Association of Dental Examiners. This was later followed by the doctors, the pharmacists, the architects, the engineers and the lawyers.

Some may wonder why the federal government does not control the registration of the professions. The Tenth Amendment to the Constitution of the United States reads as follows: "The powers not delegated to the United States by the Constitution nor prohibited by it to the States are reserved to the States or to the people."

The right to regulate the practice of the professions is a right reserved by the state, and each of the fifty states, the District of Columbia, Canal Zone and Puerto Rico have passed licensing laws to govern the practice of engineering, most of them with some special provisions to cover local requirements. A State Board of Engineering Examiners, or a similar body, is established by the law in each state to administer the law and to issue a license to practice in that state to those individuals who are found to be qualified by engineering education and experience satisfactory to the Board. An engineer must have a license to practice engineering in each state in which he offers his professional services if the health, life or property of the public is affected.

Many applications of engineering do not fall in one of these categories and are not subject to the registration laws. Those engaged in research, in engineering teaching, in certain federal government work, in design of products for manufacturing corporations, and some others are not required to be registered under many of the state laws. However, many of the corporations and many of the government departments are urging all of their engineers to become registered

and offer various incentives to encourage them to do so. In some government departments and in a number of industrial corporations, the engineer is required to be registered in order to be elevated to certain positions of responsibility and this requirement is spreading.

The first State Board of Engineering Examiners was established in 1907, not as might be expected in the populous East but in Wyoming, a rapidly developing state which had considerable trouble over water conservation due to unqualified individuals practicing engineering and land surveying. This condition drew together several reputable engineers in Wyoming to protect the people of the state. This small group of engineers, under able leadership, with their professional reputations endangered by unqualified practitioners, went to the legislature with a registration law for engineers designed for the protection of the public, and it was passed. The registration movement in the United States was under way. Louisiana followed the next year and the movement slowly began to spread to other states.

Recognizing the need for sound professional advice in the preparation of state laws to regulate the practice of engineering, the American Society of Civil Engineers asked their Registration Committee to draft a guide to be used by the states in establishing laws to regulate the practice of Civil Engineering. Their first guide was published in the Proceedings of ASCE in 1911. The revisions which started in 1915 marked a change in procedure. A cooperative effort, which included the founder societies and several interested professional groups, has periodically revised the Model Law to keep it up to date. The latest revision is just being completed by a committee of the NCSBEE, in cooperation with representatives of eighteen engineering societies in the United States.

The purpose of this document is to assist the states when they feel revisions in their statutes are needed. By using this as a guide, the states will gradually change to more uniform laws for regulating the practice of engineering and will bring nearer the day when reciprocity of engineering licensing between states is a reality, a condition devoutly to be desired by many professional engineers and an important function of the NCSBEE.

In November of 1920, representatives of seven of the twelve states which had examining boards met in Chicago and formed the National Council of State Boards of Engineering Examiners. Its objectives were to promote the public welfare by improving professional engineering standards through efficient administration of engineering registration laws, by encouraging interstate recognition of registration of engineers; and by defining and maintaining national qualifications for registration. The movement for registration laws continued and the roster for the 53 member Boards of the United States was completed in 1956 when the Registration Act was passed in the Canal Zone.

While licensure does involve some recognition of attainments, it should be stressed that this is a recognition of minimal achievements which are deemed adequate by the Registration Board to guarantee safe performance in the applicant's field. The Board, in effect, is expressing its confidence in the applicant's ability to develop through professional practice and to achieve much higher performance as he learns the finer points of engineering design. As Mr. E. L. Morris, a well known engineer and lawyer, has expressed it: "The fact that an Engineer is licensed does not make him an Engineer, any more than does a diploma from an accredited engineering curriculum, but at least the Board has assured itself *before* he is licensed that he has been trained and that he has some background."

The proceedings of the Third EUSEC Conference on Engineering Education held in Paris in September, 1957, has an excellent summary of the criteria for professional registration in a number of European countries and the United States. It reports that most of the countries listed have certain titles for qualified engineers which are protected by law and which are enforced either by a government commission or by the professional engineering society. In summarizing his report at the conference, Dean Saville said:

"In some countries recognition is obtained by graduation from some engineering college recognized by law. In other countries recognition is obtained largely by corporate membership of an engineering society, as, for example, in the United Kingdom. Again, there is recognition not of the Engineer as such but of particular types such as diplomingenieur and the like, and official standing is granted there, frequently by particular societies and sometimes also by the laws of the country.

"The United States is unique in that there is a type of professional recognition given under the authority of the several states of the Union. It is a legal type of recognition which enables an Engineer to practice as a principal, to take personal responsibility for engineering works. It is not required for the ordinary employees of engineering firms or of the Government and is not required at all for employees of the Federal Government."

The practice followed in many countries in which the curricula offered by the universities must be approved by government agencies is not followed in the United States. Each college or university determines which curricula they will offer and their content. The proposed curriculum or its revision usually starts in the department surpervising the particular curriculum. After approval by the departmental staff, the approval of the school and college officials is required before it is offered. In some institutions the governing board of the institution must also approve the curriculum content. With 231 colleges in the United States offering 4-year curricula in one or more branches of engineering, a serious problem is faced by the licensing boards in determining the quality of the engineering education received by the applicant. All state licensing laws provide certain recognition for the completion of an engineering curriculum "approved by the Board."

With the possibility of a wide variation in subject matter and in the quality of instruction between institutions, it was impossible for each state board to make up an approved list of curricula. Several attempts to do so by state boards in the earlier years of licensing demonstrated that a central agency of qualified professional men would be required to produce a satisfactory list and keep it up-to-date. It was natural to turn to the professional societies for this service. The AIChE was the first American professional society to accredit engineering curricula offered by the colleges. The Engineers' Council for Professional Development was established in 1932 as a joint group of the ASCE, ASME, AIEE, AIME, AIChE, ASEE and NCSBEE to carry out this and other functions related to all fields of engineering education. In 1940, the Engineering Institute of Canada was admitted and these eight organizations have worked harmoniously together in ECPD to improve the quality of engineering education. The 24 member Council of ECPD is the final approving body for the annual list of accredited engineering curricula in the United States.

It is the work of its Education and Accreditation Committee, composed of 15 members, who call on over 200 engineering society-approved inspectors each year to assist in the inspections and recommendations for accreditation of curricula in engineering which are scheduled for inspection that year throughout the United States. Each curriculum is considered individually and the recommendation of the inspector is (1) not to accredit, or (2) to accredit for a specified period of one to five years, depending upon the strengths and weaknesses noted during the inspection. This report is reviewed by the Education and Accreditation Committee and its recommendation to the Council may concur or may modify the inspector's recommendation. This list is widely used by the State Boards of Engineering Examiners as the "engineering curricula approved by the Board." The latest list includes 816 curricula in 156 engineering colleges. A number of Boards will add a few curricula to this list when they are familiar with the curricula offered by the institution and are satisfied that they meet the requirements as set forth in the licensing law of their particular state.

Requirements for Registration

To receive a license to practice engineering, an applicant must be of good

character and reputation with an adequate preparation for practice through both education and engineering experience satisfactory to the Board. What work is covered by the laws controlling the practice of engineering? The Model Law defines it as follows:

"The term 'Practice of Engineering' within the meaning and intent of this Act shall mean any professional service or creative work requiring engineering education, training, and experience and the application of special knowledge of the mathematical, physical and engineering sciences to such professional services or creative work as consultation, investigation, evaluation, planning, design, and supervision of construction for the purpose of assuring compliance with specifications and design in connection with any public or private utilities, structures, buildings, machines, equipment, processes, works, or projects."

An applicant may meet the requirements for registration in several ways. Since the requirements will vary from one state to another, I shall use those as outlined in the Model Law for this discussion, as a large number of states have these requirements in their law. Later I shall cite some of the major variations from these requirements in the laws now in effect in the fifty-three states and territories.

Applicants are considered in one of the following groups, depending upon their formal engineering education and their experience:

(1) Graduation plus experience,
(2) Experience plus examination,
(3) Long established practice.

The first group, graduation plus experience, requires:

> "Graduation in an engineering curriculum of four years or more from a school or college approved by the Board as of satisfactory standing, and a specific record of an additional four years or more of experience in engineering work of a character satisfactory to the Board and indicating that the applicant is competent to practice engineering, provided that in a case where the evidence presented in the application does not appear to the Board conclusive nor warranting the issuing of a certificate of registration, the applicant may be required to present further evidence for the consideration of the Board, and may also be required to pass an oral or written examination, or both, as the Board may determine."

The second group, experience plus examination, requires:

> "A specific record of eight years or more of experience in engineering work of a character satisfactory to the Board and indicating that the applicant is competent to practice engineering, and passes a written, or a written and oral examination, designed to show knowledge and skill approximating that attained through graduation in an approved four year engineering curriculum."

The third group, long established practice, requires:

> "A specific record of twelve years or more of lawful practice in engineering work of a character satisfactory to the Board and indicating that the applicant is competent to practice engineering and providing that the applicant is not less than thirty-five years of age."

In order to simplify the work of the Board, the applicant completes a form furnished by the Board with the applicant's biographical data, formal education, character references, professional society affiliations, previous registration, any application made in another state which was denied, and his experience record listed chronologically. Under each period of engineering experience, the applicant is usually required to briefly outline the most important problem that he had to solve and how he solved it. This is quite helpful to the Board in analyzing whether or not the applicant has had progressive training, and also whether or not he has had good engineering design experience. The applicant is also required to break down the time on each major assignment into how much time he considers as sub-professional, how much professional and, of this time, how much is on design. The name and address of the immediate supervisor is also required. When the application is received by the Secretary of the Board, questionnaires are sent to

each of the references listed and to the character references to get first-hand information on the character and engineering ability of the applicant from those who presumably know him best. These are given appreciable weight by the Board in evaluating the application. In the case of a derogatory report, the Board usually weighs the evidence, sometimes asks for additional information, and sometimes calls the reference by telephone to further amplify some statements.

In one group are those who have graduated in an approved engineering curriculum. Based on the record, the Board decides whether the applicant is qualified for registration as a Professional Engineer or whether further evidence of his ability is needed. While many of the state laws do not require written examination of all applicants in this group, it is authorized in the law. Unless an applicant's record is outstanding and also in order to facilitate an applicant's registration in another state at a later date, many state Boards now require a written examination if there is any question about the engineering experience of the applicant. This is especially true for those with less than twelve to fifteen years' experience under the supervision of registered engineers. The revision of the Model Law which is now being made will reflect this thinking and will probably require a written examination of all applicants. Those over 45 years of age may be excused from the first eight hours of the examination which covers the fundamentals of mathematics, physics, chemistry and the engineering sciences, and be required to take only the second eight hours which cover the principles and practice of engineering in the applicant's chosen branch of engineering.

In a second group are those who did not graduate in an approved engineering curriculum, those who may have completed a curriculum not approved by the Board, or who may not have attended any college. Satisfactory completion of one or more years of an engineering curriculum is given reasonable credit toward the eight years' experience in engineering work required under this classification. The experience must be in the nature of progressive training and self-study. It is found that much of the experience claimed by the applicant is of such routine sub-professional character that it cannot be counted as "engineering experience satisfactory to the Board." If the Board is satisfied with the experience record, the applicant is then allowed to take the two-day written examination and when he passes it he is given his registration as an engineer. We find that the number of persons who qualify under this section of the law is rapidly decreasing as both the standards of engineering education and the requirements of the registration laws are being raised. It is expected that the number who will qualify to practice under this provision will be very small in the future, but we do not feel that we should completely shut the door to those who, by diligent study and work under the supervision of well-qualified engineers, may be able to qualify for registration. The revision of the Model Law will raise the experience required from eight years to twelve years.

In the third group, long established practice, are those who have had many years of lawful practice in engineering in some category that did not require registration but who may now wish to be registered or, due to a change in position, may be required to become registered. This is sometimes referred to as the "eminence clause" and it causes more discussion among engineers and particularly those on the registration boards than any other classification. It is the general feeling that very few are eminent and this classification is being used very little at the present time, even though it is in a number of state laws. The revision of the Model Law, now being completed, will probably not include any provision for eminence.

An important activity of the National Council of State Boards of Engineering Examiners, to simplify interstate registration for those engineers who have been registered in at least one state, is the National Bureau of Engineering Registration. On application, this Bureau issues a certified record to qualified engineers after they have been registered in one state, if their professional records contain conclusive evidence that they are fully competent to practice engineering and

that they have actually had responsible charge of engineering work of magnitude and complexity and have made important engineering decisions thereon. These certificates are good for five years and certify the record of the applicant, which he can use in applying to other state boards for registration. The records can be updated after five years. Thirty-five of the state boards accept the certificate as final and conclusive evidence and will issue a license to practice in that state based on the certified record. Fifteen additional boards accept this record as useful and supplemental data and give it appreciable weight in considering the applicant for a license. Only three State Boards do not recognize the National Bureau certificate.

After the passage of the Wagner Labor Act in the 1930's and its revisions under the provisions of the Taft-Hartley Act, the engineering profession experienced a serious problem with engineers being forced into labor unions as industrial employees. As a result of this, a movement was started by the engineering societies to label them as trainees for the engineering profession in order to prevent the labor unions from forcing them into the union. A number of State Boards of Engineering Examiners instituted the title of Engineer-in-Training for students who graduate in an approved engineering curriculum. They are allowed to take an eight-hour written examination upon graduation and when they pass this examination they are issued a certificate as an Engineer-in-Training. A few states do not require the examination of graduates of an EC PD accredited curriculum. This classification does not give them a license to practice engineering but it does establish them as potential engineers. A student who has completed a curriculum which is not on the approved list of the State Board and who has completed four years of engineering experience is allowed to take the eight-hour written examination. If he passes, he is also classified as an Engineer-in-Training by the State Board. This classification marks the E.I.T. as a future professional and, under an amendment to the Taft-Hartley Act regarding professional employees, the E.I.T. is exempted from required union membership when he is employed by a company which has a union shop.

When the E.I.T. applies for his engineering license, he is given credit for the examination required on the fundamentals if certified by a written examination, which usually takes the first eight hours of the examination schedule. This classification serves several purposes:

First, it gives the engineering graduate an opportunity to take that part of the examination which covers his college work while it is fresh in his mind.

Second, it protects him from the pressure of labor organizers if he works for a unionized industrial concern, unless he wants to join the union.

Third, it further instills in the young engineer a sense of professional standing and gives him an added incentive to complete his registration as an engineer at the earliest possible time.

Forty-five of the State Boards have a provision for the E.I.T. classification. Most of them provide for both the engineering graduate and the non-graduate as explained above. The program is considered as a significant step in encouraging the registration of a larger percentage of our engineering graduates than have done so in the past and also in instilling a better professional attitude in our future engineers.

In order that you may more fully appreciate some of the difficulties encountered by an engineer in obtaining a license to practice engineering in several states, I wish to point out some of the variations in the state laws.

First, let us consider the graduate of an ECPD-accredited curriculum. This applicant is a graduate of a curriculum accepted as "approved by the Board." The committee on the revision of the Model Law of NCSBEE under the chairmanship of Col. William M. Spann of Missouri reported to the annual meeting of the NCSBEE last year that 26 Boards require these graduates to have four years of engineering experience and pass a sixteen-hour written examination, twelve Boards require graduation plus four years' engineering experience, and eleven other methods are used by the remaining

Boards, employing varying combinations of two to four years' experience and seven to twenty-four hour examinations.

For non-graduates, we find that twenty-six Boards require eight years of engineering experience plus a sixteen-hour written examination.

Eminence, long established practice and other methods vary and no particular pattern is indicated. For older applicants, eleven Boards have no special provision, nine Boards use proven outstanding reputation as a basis, eight Boards use age 35 plus twelve years' experience plus four years in responsible charge of engineering work and the others are quite variable, including such requirements as a minimum age of 35 to 40 years, oral examinations, outstanding experience, or a specified number of years of satisfactory experience.

The registrant in a state with the higher standards for obtaining a license will not experience any appreciable difficulty when he applies for registration in other states. But consider the registrant in a state which, to take an extreme case, requires only two years' experience following graduation and no written examination. About a year later his firm receives a commission to design a large industrial plant in another state. His responsibility on the new assignment requires registration in the other state. He applies for registration and when he receives the forms and a copy of the licensing law he finds that they require at least four years of engineering experience satisfactory to the Board and the passage of a two-day written examination. Since he does not have the four years' experience, he cannot be admitted to the examination and further action is postponed until he has had sufficient experience. The firm must now replace him with someone who can qualify for registration. This young engineer has lost an opportunity for advancement through no fault of his own. Lax requirements for registration in his own state caused false hopes to be built up both by the engineer and by his company.

Future Trends

Thus, we see that in order to establish reciprocity of licensing between states, considerable changes in the laws of a number of states must be made. The next question that arises is, "Shall we move up or down in our requirements?"

If we are to improve our services to the public, we can only do this by moving the requirements to a higher level. In doing this, however, we must profit by the mistakes of other professions and raise our requirements at a reasonable pace. If we move too fast and put the requirements so high that many with reasonable qualifications are excluded, we will encourage abuses by those in power who are licensed and circumvention of the law by those excluded. At the other extreme of the spectrum, if our laws are so lax that the Boards are required to license those who are actually unqualified for engineering practice, we will bring the engineering profession into disrepute and the public will soon demand better service in other ways. The public will determine whether the benefits received can be better rendered by greater governmental domination or by no controls at all. So, for example, it is easy to imagine a once highly respected engineering profession disintegrated by the abolishment of registration laws and various segments of the practice taken over by scientists, engineers, plumbers, electricians, surveyors, technicians, mechanics and unskilled apprentices at all levels, each claiming ability to perform more than they are qualified to do.

History records the downfall of professions that once enjoyed great power on account of abuses of that power. Take, as an example, the ministerial profession. In many countries at one time, the church and state enjoyed a very close relationship. At one time in England the representatives of the church were state officials, holding seats in Parliament and operating ecclesiastical courts with the power to try and to punish a wide variety of offenses. Then consider the standing and the power of that profession in the United States today. One of the reasons for the migration to the United States was to obtain freedom from political and religious domination. The separation of church and state was a basic issue in the original union of the thirteen states that formed the United States of America and

the powers of the church in civil government were removed when the Constitution was adopted.

It is our responsibility to see to it that the engineering profession avoids both extremes and by a gradual increase in the requirements for admission to practice engineering that it sets a reasonable pace for the progress of professional standards.

Thus, it will take years of work to obtain the emerging pattern of uniformity in the state laws. We probably will never realize complete uniformity of the laws in all states, nor is it necessary, if we obtain sufficient uniformity of the requirements for registration to make it possible for engineers to be registered in several states without undue hardship.

Care must be used in the revision of our registration laws. The states with the higher requirements must move gradually higher as the training for engineers is improved. Those states with lower standards for registration must move faster to a more uniform standard with those states that have the higher requirements in order that the standards of the profession will be recognized and accepted by the public, and in order that reciprocity of registration between states will become more widespread.

The fact that all of the states and territories in the United States, the provinces of Canada, and many other countries have registration laws to regulate the practice of engineering is strong evidence that the public demands them. We must now, through the cooperation between State Boards, develop policies and practices in the interpretation of our registration laws to assist us in building up the engineering profession by giving proper appraisal to those who wish to practice engineering in the future.

Teaching Positions Available

ASSOCIATE PROFESSOR OF INDUSTRIAL Engineering, masters degree necessary, Ph.D. and/or P.E. desirable. Major interest and experience in production and operations research. Opportunity to succeed present department chairman in 1962, and to develop consulting practice. Prefer engineer with considerable industrial experience who would like to enter teaching as a career. Salary open. Mature engineer 40–55. North Dakota.

ASSISTANT PROFESSOR TEACHING position in mechanical engineering department available in fall 1961. M.S. degree in mechanical engineering and some experience is desired. Ten-month basis. Write to chairman, M.E. department, University of Nevada, Reno, Nevada.

ASSISTANT PROFESSOR OF ENGINeering Graphics and Machine Design. Must have M.S. in Engineering and some professional design experience. Teaching experience desirable. Begin in Fall of 1961. Delightful surroundings; affable associates. Write to: G. S. Dobbins, Acting Head: Department of Engineering Graphics and Machine Design, University of Colorado, Boulder, Colo.

MECHANICAL ENGINEERING. MAN required in the machine design area starting September 1, 1961. Excellent opportunity to teach and direct undergraduate and graduate programs. Develop courses and research for a new Cooperative Ph.D. program which is sponsored heavily by local industries and a sizeable foundation grant. Salary and rank will depend on educational background and experience. Write to J. W. Bunting, Head, Mechanical Engineering Department, University of Cincinnati, Cincinnati 21, Ohio.

MECHANICAL ENGINEERING teaching and research positions in heat transfer-thermodynamics and materials science. Attractive opportunities are available due to departmental expansion. Ph.D. required. Write to Donald M. Vestal, Jr., Head Professor, Mechanical Engineering, Auburn University, Auburn, Alabama.

ELECTRICAL ENGINEERING teaching positions open in the areas of circuits, microwaves, and electromagnetics. Ph.D.'s preferred. One opening starting February and another opening starting September, 1961. Possibilities for research and consulting. Send resume to L. J. Galbiati, Dept. of Elect. Engr., Merrimack College, North Andover, Massachusetts.

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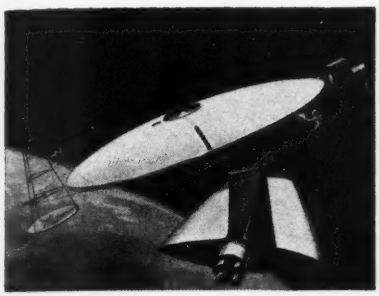

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